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CANADIAN

Electrical News

AND ENGINEERING JOURNAL

FIFTEENTH YEAR.
No. 1.

TORONTO, MONTREAL AND WINNIPEG, JANUARY, 1905

PRICE 10 CENTS
$1.00 PER YEAR.

STATEMENT OF FACT

The **Only True Measure** of the **Normal Capacity** of a properly designed Generator is the **Current** it will develop **Safely** under **Short Circuit** with normal **Fully Excited**) **Field** within a (stated) temperature for a given period of time, the **Maximum Capacity** being the current at safe temperature under **Fully Saturated Field**, short circuit to be applied when the generator is giving out its standard voltage, and the **same test** should be made **on all** direct current motors and synchronous alternating motors, by operating them as generators.

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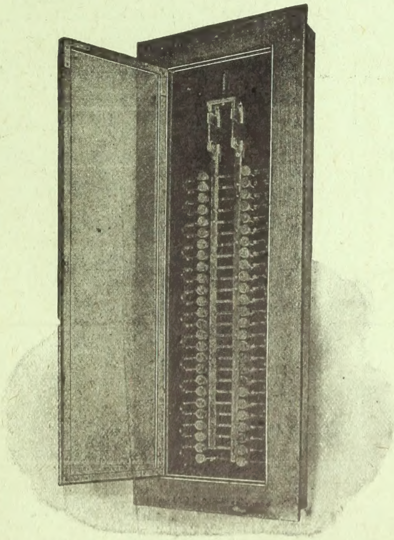

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TELEPHONE LIGHTNING ARRESTERS, ETC.

Section 2 of our Supply Catalogue illustrates and describes the above lines.
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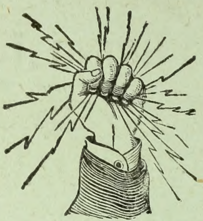

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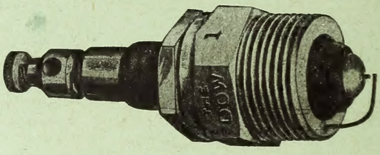

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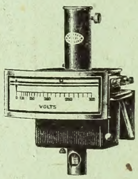

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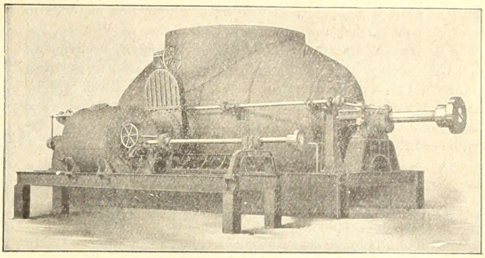

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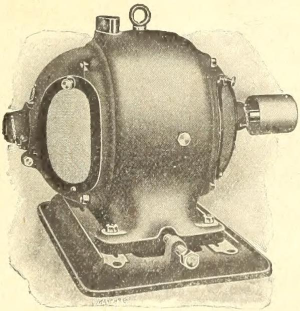

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A. C. ELECTRIC TRACTION FROM GAS POWER.

A somewhat unique departure from established methods in electric traction has recently been undertaken at Warren, Pa. The Warren & Jamestown Street Railway Company is equipping an A. C. single-phase electric railway system to operate between Warren, Pa., and Jamestown, N. Y., for which power will be supplied by gas engines operating upon matural gas. The equipment is now being constructed by the Westinghouse Companies of East Pittsburg, Pa.

The power station will be located at Stoneham, Pa., two miles from Warren. The initial equipment will consist of two Westinghouse gas engines each of five hundred brake horse power capacity. They will be of the horizontal single-crank double-acting type, direct connected to two two hundred and sixty k.w. Westinghouse generators furnishing current at voltage sufficient for direct use upon the high tension transmission line. The power equipment also comprises a 55 h.p. Westinghouse gas engine for operating air compressor and exciter unit. Natural gas will be used, furnished by the local distributing company. In this district the gas has a calorific value of about 1,000 b.t.u. per cu. ft.

Transformer substations, five in number, will be located along the right of way. These will receive the high tension current from the transmission line and reduce the voltage to such an extent as to render it more suitable for use in single-phase motors. The present motive power equipment will comprise four quadruple sets of Westinghouse single-phase motors each approximately 50 h.p. capacity.

An interesting feature of the system is the arrangement for operating the alternating current motors upon the direct current trolley lines within the city limits of the termini.

The Warren & Jamestown Street Railway is not a newly organized system, as it has operated part of the present lines for a period of eleven years. Three years ago the company began experimenting with the use of gas power, with sufficient success to influence them in the now exclusive adoption of gas engines for their entire power generation. The operation of the new system will be watched with much interest by the engineering public, and its success will mark an important advancement in modern electric railroading.

SPARKS.

Robert H. Gale has registered the business of the Slade Electrtc Company, electrical contractors, Quebec.

In Thamesville, Ont., a by-law to manage the electric light plant by a board of commissioners was defeated by five votes.

Although the ratepayers of Calgary, N. W. T., have decided to raise $60,000 for a municipal lighting system, it has not yet been decided whether to purchase the existing plant or install a new one. It is probable that the company will be approached with the object of giving more favorable terms.

Mr. J. S. Campbell, of St. Catharines, Ont., has made application to the Dominion Parliament for an act authorizing the Niagara-Welland Power Company to use their proposed canal for navigation purposes, to construct a tramway along its right of way, and to extend the time for the completion of the works.

The electric light plant which has been installed by the municipality of Edmonton, N. W. T., consists of two Babcock & Wilcox boilers, two Robb-Armstrong engines of 600 and 350 h.p., and two Bullock alternators of 450 and 225 kilowatts, also two direct connected exciters of 22½ kilowatts. The engines are arranged to run condensing.

The City Council of Kingston, Ont., have decided to give Mr. J. M. Campbell the privilege of bringing electric power from Kingston Mills to his mills on Ontario street in that city. Mr. Campbell was given a perpetual franchise, but it was shown that this would not be detrimental to the city. The power can only be used for the mills situated within two blocks.

After operating a municipal lighting plant for some years, the City Council of New Westminster, B.C., have entered into a contract to purchase power from the Vancouver Power Company. Ald. Vanstone, of the Electric Light Department, estimates that this year the saving to the city under the new arrangement will be $8,000. He states that the disadvantages of a power plant owned by a small city like New Westminster are many.

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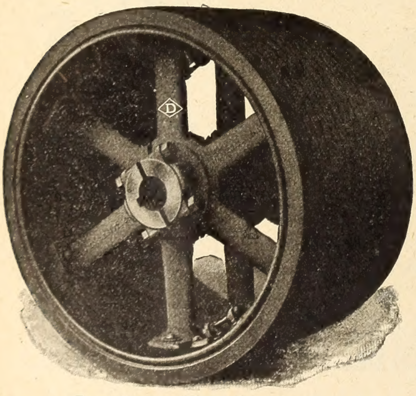

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TORONTO MONTREAL

SPARKS.

The electric light plant at Eganville, Ont., is to be increased by the installation of a new generator.

The Springhill Electric Light Company, Springhill, N. S., have recently installed a new C. G. E. generator and a 120 horse power engine, the latter being supplied by the Seymour-Mackintosh Company, of Auburn, N. Y.

The King Asbestos Mines, recently incorporated by the Quebec Legislature, are given power to acquire and develop water powers for electrical purposes. The promoters include Mr. H. M. Whitney, of Boston, and Mr. Edward Slade, of Quebec.

Ellsworth Birkett, an electrician in the employ of the Brantford Electric & Operating Company, Brantford, Ont., was instantly killed in the power house while turning on the arc lights. He was thirty-five years of age and had been in the employ of the company for twelve years.

The property owners of Ottawa overwhelming defeated the by-law to purchase the electric railway at the company's price, namely, $3,000,000. The vote stood 819 for and 3,557 against. The present franchise has 18 years yet to run, when the city will be able to acquire the property by arbitration.

Messrs. T. McAvity & Sons, St. John, N. B., have recently installed a lighting plant in their Broad street foundry. It consists of a 11½ k.w. Crocker-Wheeler compound generator, slate switchboard, and arc and incandescent lamps, and was installed by Mr. Frank P. Vaughan, electrical contractor.

The life of Mr. W. McLea Walbank, vice-president and chief engineer of the Montreal Light, Heat & Power Company, was recently threatened by a former employee, who went to his residence and flourished a revolver before him. A struggle ensued, Mr. Walbank succeeding in breaking away and locking himself in a room. It is supposed that the mind of the would-be assassin was deranged.

Messrs. J. R. Booth, E. H. Bronson, and W. Y. Soper, acting for the proprietors of the water power at the Chaudiere, Ottawa, recently waited upon Sir Wilfrid Laurier and urged that steps be taken to have a judicial determination of the question as to whether the ownership of river beds is vesetd in the Federal or Provincial authorities. A dispute has long existed between the owners of power on the Ontario and Quebec sides of the Ottawa River, respectively, as to the amount of power which each had the right to take. The former obtained their rights from the Dominion Government, and the latter from the Quebec Government. It was agreed two years ago to submit a case to the Supreme Court and to settle the question of jurisdiction. For this purpose a number of questions were drawn up, but the Quebec owners objected to them.

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Dynamos, Motors, Transformers, Arc Lamps and Meter Repairs.
Lowest Prices consistent with High Class Work.
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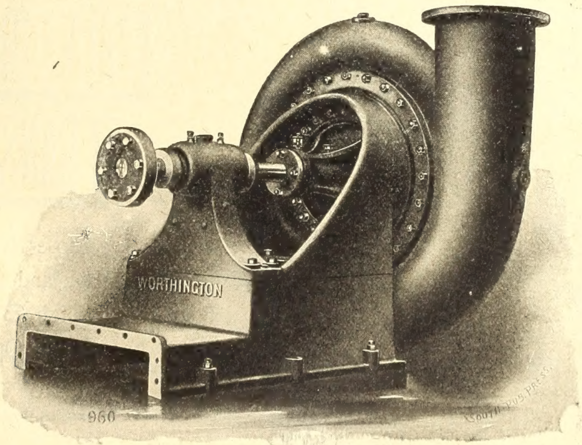

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Capacity, 10,000 gallons per minute against 25 feet head.

Worthington Turbine Pumps are Reliable, Durable, Efficient and Exceedingly Simple

The John McDougall Caledonian Iron Works Co., Limited, Montreal, Que.

BUILDERS FOR CANADA

SPARKS.

The municipality of Ladysmith, B. C., will install an electric plant.

The Bathurst Electric Light Company have completed their new electric plant at Bathurst, N. B.

Mr. Breithaupt, who operates the Berlin and Waterloo Street Railway, proposes extending the road to Breslau shortly.

The electors of Milton, Ont., have voted in favor of raising $8,000 for the purchase and improvement of the electric light plant in that town.

The ratepayers of Guelph, Ont., have approved of a by-law to raise $30,000 to extend and improve the electric street railway and purchase a park.

The Winnipeg, Selkirk & Lake Winnipeg Railway Company are seeking amendments to their charter to permit them to enter the city of Winnipeg.

The Town Council of Preston, Ont., have purchased the old power plant of the Galt, Preston and Hespeler Street Railway Company for $2,000.

Messrs. W. Moore & Sons, of Meaford, Ont., have refused to accept the Council's offer of $8,600 for their electric light plant. They ask $12,000.

The Wallaceburg Electric Light Company,Wallaceburg, Ont., has been succeeded by the Premier Electric Light & Power Company, Limited.

The ratepayers of Exeter, Ont., have recommended that the Council secure an option on the electric plant owned by Mr. C. B. Snell with a view to purchase.

The Pine Creek Power Company, Limited, of Victoria, B. C., propose to increase the capital stock of the company by $50,000. Mr. A. L. Belyer is secretary.

The ratepayers of St. Thomas, Ont., have approved of the purchase of the gas and electric plants at the price fixed by the arbitrators, namely, $205,000. The majority was 615.

Fort William, Ont., proposes to expend $6,000 on improvements to the electric light plant, including $500 for new transformers, $558 for wire and $499 for poles and fittings.

The Peterboro Radial Railway Company are considering the extension of their electric road to Lakefield, Ont. It is probable that a double track will be laid next summer on George street.

The Canadian General Electric Club held a very successfu concert in St. George's Hall, Toronto, on December 14th, when an entertaining programme of songs and instrumental selections was rendered.

The St. Johns Electric Light Company, St. Johns, Que., are now obtaining power from the Chambly plant of the Montreal Light, Heat & Power Company and will discontinue the use of steam entirely.

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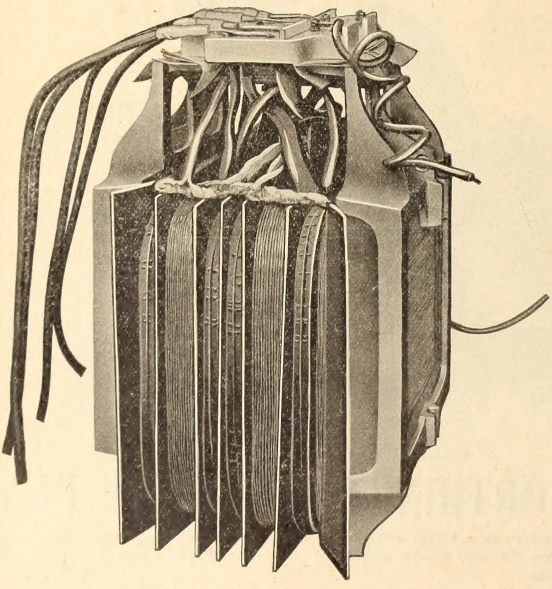

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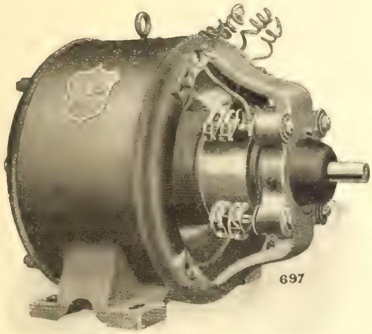

Open Motor Without Sub-Base or Pulley.

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DIRECT-CURRENT MULTI-POLAR

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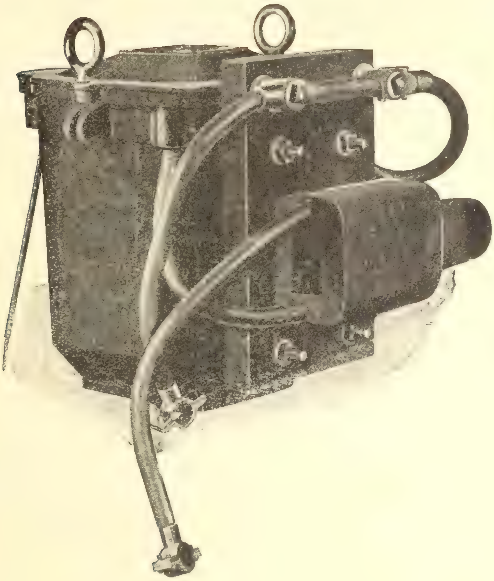

Thawing

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Pittsburgh Transformer Company
Pittsburgh, Pa.

ADDITIONS TO ELECTRIC PLANT.

The Toronto Electric Light Company have now in operation the first turbo generator set to be manufactured and installed in Canada. It is a 500 k.w., three-phase, 60 cycle Curtis turbine wound for 2,300 volts and was built by the Canadian General Electric Company. It has been found entirely satisfactory in operation. The same manufacturers are also building for this company two turbo-generator sets of 2,000 k.w. each, which will be completed and installed this spring.

Alterations are also being made at the power house of the company at the foot of Scott street to provide accommodation for a new switch-board and rotary converters. The space occupied by the general offices before the erection of the new building on Adelaide is being divided by a concrete wall extending across the entire width of the building thus providing a thoroughly fire-proof room 48 x 18 feet. In this will be installed a 12,000 volt switchboard of modern design and embodying several new features, also two 1,000 k. w. rotary converters, all of C. G. E. manufacture. These, it is expected, will be installed by April 1st next, and the company will then be in a position to supply Niagara power at 25 cycles three phase. The company contemplate the utilization of the Niagara power not later than July, the intention being to purchase the necessary supply from one of the companies in operation until the plant of the Toronto and Niagara Power Company is completed.

SPARKS.

The St. Johns Street Railway Company are evidently not yet through with their programme for improvements, as during the past month they have placed orders for additional equipment to the value of $50,000.

The Commercial Oil Company, of Hamilton, has been incorporated, with a capital of $100,000. The provisional directors are Messrs. J. C. Person, G. L. Person, C. Goring, W. C. Person and W. G. Morrison.

The Stationary Engineers Association of Victoria, B. C., have elected the following officers for 1905: President, M. Hutchison; vice-president, T. Watson; secretary, A. M. Aitkens; treasurer, T. Barraclough; conductor, L. Hether.

The Westinghouse Electric & Manufacturing Company have just received an order through their agents, Takata & Company, of Tokio, for thirteen direct current generators, each of 62.5 kw. capacity, and thirteen spare armatures. Each will be driven by a 125 h. p. steam engine, and the thirteen engines will be supplied by the Westinghouse Machine Company.

The Westinghouse Electric and Manufacturing Company have closed a contract with the Ontario Power Company for an alternating current generator with a rated output of 10,000 horse-power at 85 per cent. power factor. This is in addition to three other machines of similar type which the Westinghouse Company are furnishing for this plant. The generators are of the revolving field, two-bearing type, designed for direct connection to water-wheels; they generate three-phase current at 12,000 volts and 25 cycles, and run at a speed of 188½ r.p.m. Among other apparatus included in the contract are twelve 3000 k.w. oil-insulated water-cooled transformers, wound for 12,000 and 60,000 volts, two 375 k.w. exciters, and complete switchboards.

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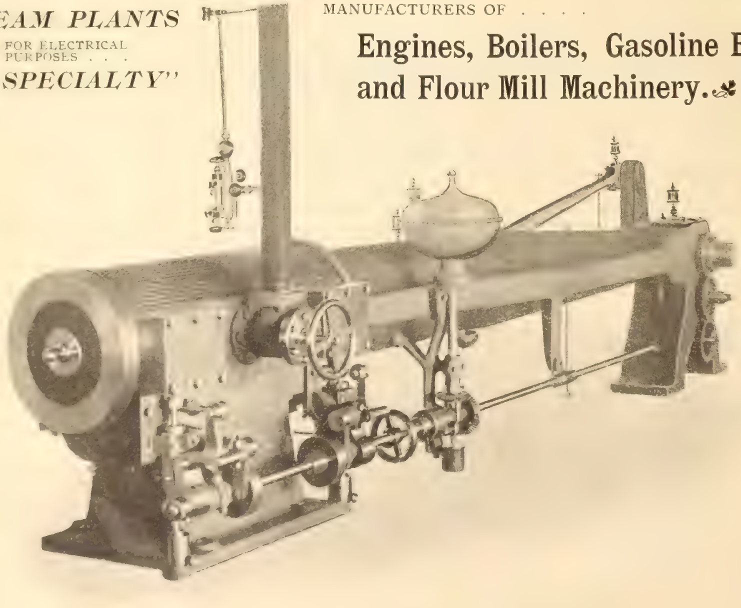

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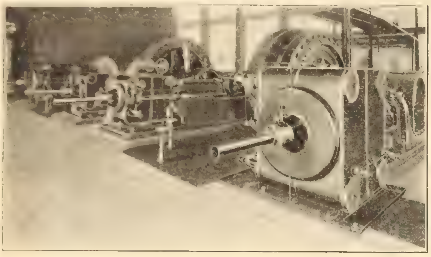
SPARKS.

The New York Edison Company, after exhaustive tests upon 600 lamps, have recently placed an order with Edward E. Cary, importer, of Montclair, N.J., for 48,000 globes of the "Cohesive" type.

The long distance telephone line connecting Vancouver and Victoria, B.C., has been completed and was put in operation for the first time last month. The charge is 50 cents for one minute and ten cents for each additional 15 seconds.

The Ottawa Electric Company, after a careful competitive test of the various makes of carbons on the market, are understood to have placed an order with Edward E. Cary, of Montclair, N.J., for their requirements in inner globes and carbons for 1905.

The Montreal Terminal Railway Company are seeking authority from the Dominion Government to build an electric railway from Montreal through the counties of Hochelaga, Maisonneuve, Jacques Cartier, Chambly, Vercheres, Laprairie, St. Johns, Iberville, Rouville and St. Hyacinthe, in the province of Quebec. An electric railway is also projected to run westerly from Three Rivers, Que., to Ste. Anne de la Perade through St. Maurice, Maskinonge and Champlain.



This Illustration

Gives a general view of the two Cross Compound Non-Condensing Engines in the Cataract Power & Light Company's plant at Hamilton. They are direct connected to Westinghouse Alternate Current Generators, of 1,000 kilowatt capacity, and 8,000 alternations at 100 revolutions per minute. Diameter of Cylinders—high pressure 28", L. P. 52", stroke 46". Initial pressure 150 lbs. Rated load 1,500 horse power. Maximum load 2,250 horse power. The generators run in parallel with the turbine driven alternators at the water power station 30 miles distant.

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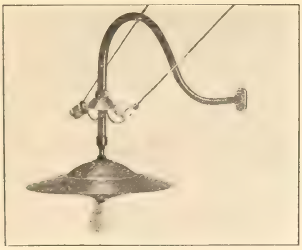

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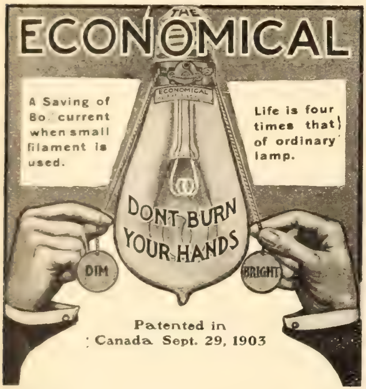
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"PULL STRING" TURN DOWN LAMP

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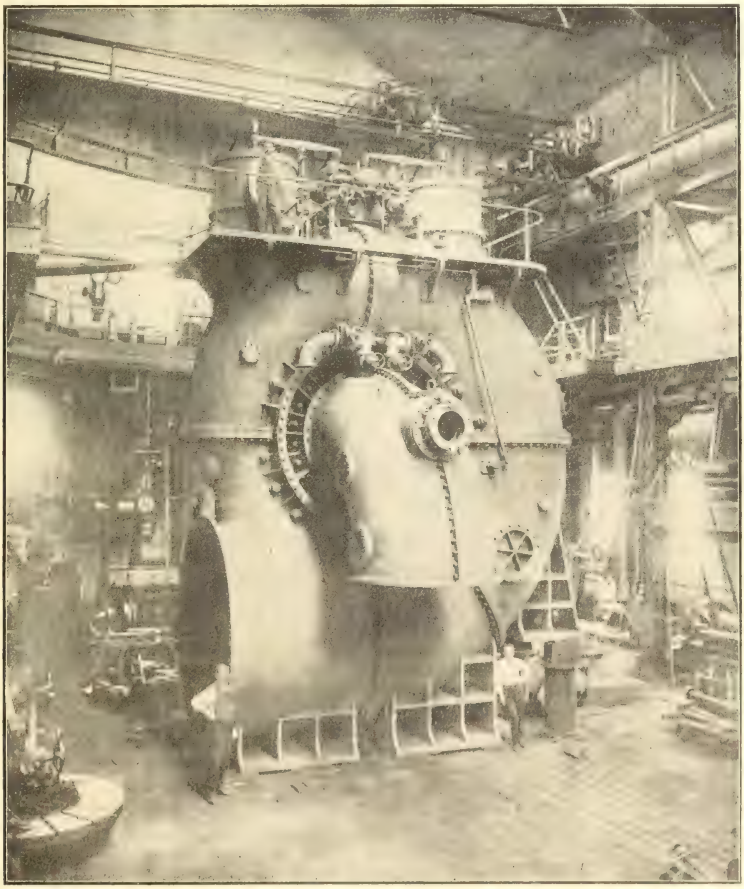
CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

Vol. XV. JANUARY, 1905 No. 1.

A 10,500 H. P. WATER WHEEL.

The illustration on this page represents a 10,500 h. p. water wheel which the I. P. Morris Company, of Philadelphia, recently installed in the power house of the Shawinigan Water and Power Company at Shawinigan Falls, Quebec. Some facts in regard to the turbine are interesting : It is 30 feet from base to top ; 22 feet wide ; weighs 364,000 pounds ; shaft is of forged steel, solid, 32 feet 3½ inches long, 22 inches in diameter in center, tapering to 16 inches on the generator side and 10 inches on the other side ; the distance from center to center of shaft bearings is 27 feet ; the shaft weighs 10 tons ; the runner is of bronze and weighs 5 tons ; the intake is 10 feet diameter, and the water is discharged through two draft bends, one on either side, and one of which is shown in the illustration.



10,500 H. P. Water Wheel Installed by the I. P. Morris Company for the Shawinigan Water and Power Company.

The wheel proper is intended to operate at a speed of 180 revolutions per minute, under a head of water varying from 125 to 135 feet. The quantity of water going through the turbine when developing the full power is 395,000 gallons per minute. Some idea of the quantity of water which this means may be gathered from the fact that it is equal to a river 88 feet wide and 10 feet deep, having a constant flow of 60 feet per minute.

The remarkably short time in which this turbine was designed and built by the I. P. Morris Company is worthy of note. The contract was not signed until May 19th, and the photograph was taken October 2nd, 1904. In shipment the turbine required five flat cars and one box car, and a special route had to be selected where the bridges were high enough to allow the huge parts to pass under.

AN INSTALLATION OF ELECTRIC POWER FOR A QUEBEC MINE.

The old and important Eustis Mine at Capelton, P.Q., which has been a steady producer for over thirty years of sulphur, copper and the precious metals, has recently had important alterations made in the motive power by which its mining operations are conducted. Electricity generated by water power has been substituted for steam power, and the installation has been so arranged that in case of deficiency in, or stoppage of, the electric power a delay of only a few hours will substitute steam, so that operations under ground need not be suspended.

The annual output of the property is from 25,000 to 30,000 tons, and about 150 persons are employed.

The electricity for the plant is generated by a water power situated on the Coaticook River, about one mile above its junction with the Massawippi. At this point a wooden dam, about fifteen feet high, has been built. At one end of this dam are placed the head-gates from which a wooden pipe, seven feet in diameter, carries the water to the power house situated 340 feet farther down the river. Just outside of the power house this wooden pipe is led into a twelve-foot stand pipe or penstock, thirty feet in height, to which is connected, directly opposite the wooden pipe, a steel tube, also seven feet in diameter, which takes the water from this stand-pipe directly to the turbine case. The stand pipe is provided with an overflow, six feet above the normal water level, designed to take care of the back rush of water when the wheel gates are suddenly closed, but in practice it has been found to be seldom necessary. The water wheels are of the Crocker pattern and were built by the Jenckes Machine Company, Ltd., of Sherbrooke, P.Q.; they consist of two pairs of eighteen inch wheels mounted on one shaft. The wheels are set in one steel case, the setting being of the type known as "central discharge," that is, each pair of wheels discharges into a central draught compartment weich is provided with a single draft tube or discharge pipe. The turbines were designed to furnish 450 h.p. at a speed of five hundred revolutions per minute under a head of thirty-two feet, but the plant is now running under a head of thirty-six feet. In the design of the power house provision has been made for a third pair of water wheels, and these will be placed in an extension of the present sheet steel casing; the inlet tube is large enough to supply the three pairs of wheels without making any deficiency of water for any one of the three pairs.

The turbine shaft is directly connected to a 200 k.w. Westinghouse three phase 2,200 volt, 25 cycle, rotary field generator. The exciter has 7½ k.w. capacity and is operated at 875 revolutions per minute by a separate 9-inch Crocker turbine, which also is directly connected. The electrical controlling and connection apparatus is mounted on a single panel switchboard. The leads from the machine are brought to the board through a tile pipe laid under the floor. The power line from the switchboard is taken through the end wall of the building across the river to the mines (a distance of about two miles), and consists of three No. 1 hard drawn copper wires, spaced eighteen inches apart, in the form of a triangle on the poles.

At the receiving end of the power circuit there are three stations, one for the air compressor, one for the hoist, and one for the crushing machinery. The air compressor house is placed just outside the entrance to the mine tunnel. The compressor is of the two stage type and is a Canadian Rand Drill Company's class D-2, belt driven, cross compound machine, fitted with a Rand water tube intercooler. The cylinders are 13 inches by 18 inches and 20 inches by 18 inches, with Corliss inlet valves on the low pressure cylinder. The compressor is driven by a 100 h.p. Westinghouse, 2,000 volt, constant speed, induction motor controlled by a switchboard on which are mounted the starting switch, fuses, etc.

View of Dam on Coaticook River, Eustis Mining Co

The hoist is situated at the inner end of an adit tunnel, 1,000 feet long, through which the power is carried by three No. 4 weather proof wires, which are further protected by being placed in a heavy wooden box bolted to the rock wall of the tunnel. This hoist, which was designed and built by the Jenckes Machine Company, Limited, of Sherbrooke, Que., is placed about twenty-five feet above the tunnel level in a chamber cut out of the solid rock. It has two cast iron drums, 72 inches diameter by 48 inches face, mounted on separate shafts which are 6 5-16 inches in diameter; both drums are driven by one motor through a double set of gears. The drums are connected to the motor by friction clutches of the Lane type, and are provided with band brakes and indicators, which show the position of the skips in the shaft at all times. The clutches and brakes were designed to be controlled by levers operated either by air or by hand; in practice, so far, only the hand levers are used. The motor for the hoist is a Westinghouse 150 h.p. three-phase, 2,000 volt, type F variable speed induction motor, with a normal speed of 480 revolutions a minute. The controller is mounted on the engineer's platform and has seven steps ; it acts by connecting different resistances, in series, with the rotating part of the motor. These resistances are entirely separate from the machine, being connected with it by means of three slip rings.

The mine incline varies from forty-five degrees to twenty degrees as depth is obtained. At present it has a depth of over 2,000 feet, and is equipped with double tracks of four feet gauge laid with 56 pound steel rails. The skips are self dumping and are not run in balance. These skips discharge into bins, the bottoms of which are about five feet above the tunnel track, which allows the cars running on the latter to be loaded through hoppers. The nominal speed of the hoist is five hundred feet a minute, but it has been found in actual practice that it only takes from five to six minutes for the skip to come from the bottom of the mine, discharge its load, and return again to the bottom. The total load hoisted (rope, skip and ore), is from 7½ to 8 tons.

The crushing plant is situated by the side of the railroad track, about three-quarters of a mile from the mouth of the tunnel. This plant is supplied with power by a branch from the main line, and the machinery at present consists of a 20 inch by 6 inch Farrel crusher with a set of geared rolls used for reducing the hard ore to fines. This hard ore occurs in parts of the mine but not in all. The two machines (crusher and rolls), are driven by a 50-horse power, 200 volt, slow speed, type C, Westinghouse induction motor, supplied through two 25 k. w. transformers. Electrical measurements indicate that these machines take about 40 h.p. when crushing eight tons per hour. This plant is only a temporary one, to be used until the new mill, now under construction, is completed. The new mill will be driven throughout by 2,000 volt motors. It is designed to handle all the ore from the mine, and will both dress the rich ore for shipping and crush and concentrate those ores which are too lean to ship.

The hoist is so designed that, in case of accident, it may be operated by steam power by simply coupling an engine to each end of the countershaft of the new hoist, an operation which will require very little time. Steam will be supplied to the engines by old boilers, located about fifty feet away, the stacks from which consist of two tile pipes laid up the old shaft to the surface above.

The old compound steam, single stage air compressor, built by the Canadian Rand Drill Company, which is located just over the mouth of the adit tunnel, can be used in the case of low water, or, of accident to the electrically driven compressor. Steam is supplied to this old compressor by the two 125 h. p. boilers which formerly ran it.

In a recent test of the new plant it was found that, when double the full load was on the generators (a 100 per cent. overload test) the level of the water in the stand pipe was below its normal point, and that the water in the tail race was above the normal point ; these water levels, both above and below, fluctuated rapidly and it was difficult to gauge them accurately with the means which were on hand at the time of the test. The actual head of water on the turbines is supposed to have been thirty-three feet, and if this assumption is correct the water wheels would have used, theoretically, 706 horse power of water, of which amount about 18 h. p. was consumed in the exciting generator. Allowing the main generator to have used 688 h. p. and on the assumption that it developed one hundred ampere per phase at a voltage of 2,160, and on the further assumption that the efficiency of the generator at this overload was 92 per cent., and that the power factor of the circuit (water rheostat) was unity, the brake horse power developed would have been about 543 h.p., which would give an efficiency of 78.9 per cent. for the water wheels. As the electrical measurements were not accurately taken, and as the head of water (as already mentioned) fluctuated, the results are doubtful, but the probability is that the efficiency was less, rather than greater, than the above figures. Similar tests made with the wheels operating at partial load, and therefore partial gates, showed that the efficiencies at 271 and 390 e.h.p. were respectively 51 per cent. and 65 per cent. approximately. The 271 e h.p. would represent the conditions under which the plant operates while the hoist and compressor are in use.

As the hoisting plant is quite unusual in its use of induction motors, the following consumption of power for the various stages of the hoist is given. These figures were taken by Mr. Davis (the electrician in charge), and are readings from his electrical instruments.

The method adopted in hoisting is, on receipt of the mine signal to start the motor light, and after it has gotten up to a fair speed to pick up the load with the friction and then throw the controller over to full speed. It will be noticed that this method of starting saved nearly 100 e.h.p. over the method of starting the load when the motor was at rest.

Starting Motor Light.

Instantaneous starting current.	96 h. p. for	5 seconds.
After starting with load on....	126 " "	10 "
Full load full speed..........	107 " "	

Starting Motor with Load On.

Starting current.............	191 h. p. for	20 seconds.

This adoption of electricity for motive power in mining is the first we have knowledge of in Quebec ; in British Columbia the Granby Consolidated Company have made an electric installation for tramming, crusher and other purposes.—Canadian Mining Review.

An important amalgamation of electric railway interests in Toronto has taken place, and a new company has been organized under the name of the Toronto and York Radial Railway Company. Mr. William Mackenzie is president and M. W. H. Moore general manager. The amalgamation includes the Metropolitan Electric Railway, the Mimico Electric Railway and the Scarboro Electric Railway.

The German navy officials are giving close study to the possibilities of gas engines for propelling war ships. At a recent meeting of the German Society of Naval Architects, Mr. Capitaine, of Frankfort-on-the-Main, predicted that gas would displace the present steam engines as well as turbines, and by means of models showed that gas could be successfully adapted to driving marine engines.

The Hamilton Cataract Power, Light & Traction Company recently started the two 5,000-kilowatt Westinghouse generators in their DeCew Falls power station. Power is supplied from Welland Canal feeders, tapped in about 14 miles above the power station, and at the station the water has a head of 267 feet. The Westinghouse generators are of the two-bearing type, direct connected to Escher-Wyss water-wheels, and run at a speed of 286 r.p.m. They generate 3-phase current at a frequency of 66 cycles, and a pressure of 2,400 volts.

THE DEVELOPMENT OF THE GAS ENGINE AND ITS APPLICATION TO ELECTRIC CENTRAL STATION SERVICE.

By R. T. MacKeen.

A brief review of the history of industrial development during the past century furnishes convincing evidence of the natural tendency toward the economic production of the necessities of life demanded by advancing civilization. The problem which stands pre-eminent among the many to be solved in modern times is that of cheap production and resulting minimum cost to the consumer. The solution of this problem will require the application of all the skill and ingenuity that the best men of the present and future years can supply, to keep pace with the demand.

Perhaps in no other field is this fact of greater importance than in that affecting the economical production of energy, or more properly the economical transformation of the energy stored up in our natural resources to a form in which it can be applied directly to the multitudinous uses created by modernizing influences.

The two great sources of energy at present available are those of water power and the element carbon. The development of the former is limited by considerations of location and accessibility, but the latter, due to its wide distribution and the ease with which it is rendered available, has for many years been the chief source of obtaining energy, and has, in consequence, merited the greatest attention and study of engineers engaged in industrial enterprises.

The subject of this paper is one immediately concerned with the economical transformation of natural energy into a form suitable for application to industrial processes. For many years this transformation of the energy stored up in coal has been accomplished through the medium of the evaporation of water into steam, and the utilization of the expansion of the latter to reproduce the original thermal energy in the kinetic form.

While the steam boiler and steam engine have been developed to a surprising degree of efficiency, the former thermally, and the latter mechanically, yet the transformation of the thermal energy contained in the steam into kinetic energy in the engine is attended by such losses that the maximum combined efficiency of boiler and engine is exceedingly low. For instance, the thermal efficiency of an average boiler operating under normal conditions rarely exceeds 70 per cent. and that of the engine 18 per cent., thus the combined efficiency is but 12.6 per cent. This means that out of the energy contained in one pound of coal, but 12.6 per cent. is available in the form of kinetic energy at the engine piston. Thus, any means whereby a more economical transformation can be secured merits our closest study and investigation.

The principal causes of the low efficiency of the above method of energy transformation are as follows: Incomplete combustion; inefficient utilization of the heat produced in the evaporation of water; heat lost by radiation at the boiler; heat lost by radiation from steam in its conveyance to the steam engine; radiation of heat at the engine; and the inefficient transformation of the thermal energy of the steam into kinetic energy through expansion. It is thus evident that the adoption of any means whereby the efficiency of these various operations can be improved, will result in a more economic production of kinetic energy.

As a result of investigation along the lines indicated, the development of the gas engine has, of recent years, reached such a stage that it now promises to form a potent factor in the development of power in the near future to the exclusion of steam power in a great many instances. The underlying principle of the gas engine might be stated as follows: The ecomonic transformation of thermal energy into kinetic energy by means of converting the combustible into a gas through a highly efficient process, conveying this gas to a cylinder similar in many respects to a steam engine cylinder, and there, by means of further combustion, transforming the thermal energy contained in the gas to the kinetic form.

Nature has in many cases completed the first transformation by providing natural gas in various districts, and hence losses incidental to the first transformation are avoided, where this gas is available. In this discussion, however, we shall consider the effecting of the first transformation by means of apparatus designed for the purpose and known as a "gas producer."

To illustrate the relative thermal efficiency of the energy transformation possible by means of a steam engine and a gas engine plant, let us make the following assumptions, all the values being readily obtainable in practice.

Calorific value of coal per lb. = 12500 British Thermal Units.

Thermal efficiency of producer for gas engine	80%
Thermal efficiency of gas engine	25%
Thermal efficiency of steam boiler	70%
Thermal efficiency of steam engine	18%

Thus for the gas engine we have for one pound of coal in the form of kinetic energy at the gas engine piston $12500 \times .80 \times .25 = 2500$ B.T.U.

The thermal equivalent of one horsepower = 2545 B.T.U.

Thus one h.p. at engine piston will require $\frac{2545}{2500} = 1.02$ lbs. of coal.

For the steam engine, one pound of coal consumed at the boiler will furnish in the form of kinetic energy at the engine piston $12500 \times .70 \times .18 = 1575$ B. T. U. equivalent to $\frac{2545}{1575} = 1.62$ lbs. of coal per h.p.

Hence it will be noted that the coal required to produce one h.p. of kinetic energy at the piston of the gas engine is but 1.02 lbs., as against 1.62 lbs. for the steam engine, thus effecting a saving of s7% in coal.

Having furnished a comparative idea of the relative efficiency of the two methods of energy transformation, let us now consider in detail the principle of the gas engine and its auxiliary, the producer.

Gas engines are broadly divided into two classes. The four-stroke, and the two-stroke, cycle engine. In the single acting type of the four-stroke engine there is but one power stroke in every four, the other three strokes being necessary to effect exhaustion, suction and compression, as illustrated in Fig. 1. In the single acting two-stroke cycle engine every alternate stroke is a power stroke. This is accomplished, however, at the expense of simplicity of design and the use of auxiliary apparatus, which has rendered the four-stroke cycle engine of more general adoption.

In the simplest form of the four-stroke cycle engine illustrated in Fig. 1, the cycle of operation is as follows:—The cylinder, at the moment indicated, is filled with the right proportion of gas and air compressed to the proper degree, and is then ignited either by means of a fire tube or an electric spark. The chemical reaction upon ignition results in what may be termed an explosion, and the resulting pressure causes the piston to move forward to the end of its stroke. Upon the return stroke the burned gases are exhausted through exhaust ports. The remaining momentum of the moving parts causes the third stroke to take place,at which time,through the suction produced, a fresh mixture of gas and air enters the cylinder and the return or fourth stroke still caused by momentum of the moving parts compresses the mixture to the proper degree. At the next forward stroke the mixture is again exploded, and energy is again imparted to the moving piston, and thus each cycle is completed successively.

It is evident that as only one power stroke occurs in each four strokes, the energy imparted to the piston is not constant, resulting in a varying angular velocity of the revolving elements of the engine and hence irregular power output. In order to overcome this undesirable feature various modifications of the simple acting engine have been effected, as illustrated in Figs. 2 and 3. In Fig. 2 we have a double acting single cylinder engine furnishing two power strokes in every four and in Fig. 3 is illustrated a tandem double acting engine in which every stroke is a power stroke. By this means the energy transformation takes place at more frequent intervals and hence the variation in the velocity of the moving elements is reduced to a minimum. Other modifications, such as a combination of several sets of single acting, double acting or tandem double acting cylinders linked to cranks at 90 degrees apart, still further improve this characteristic.

FIG. 1

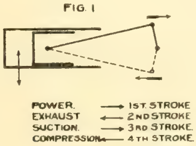


FIG 2.

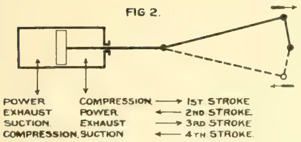
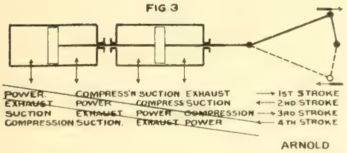
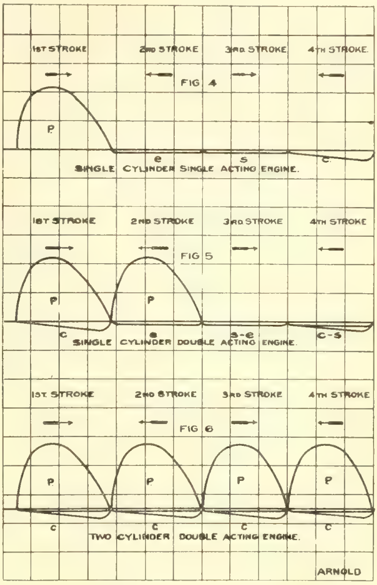

POWER COMPRESSION → 1ST STROKE
EXHAUST POWER ← 2ND STROKE
SUCTION EXHAUST → 3RD STROKE
COMPRESSION SUCTION ← 4TH STROKE

FIG 3


POWER. COMPRESS'N SUCTION EXHAUST → 1ST STROKE
EXHAUST POWER COMPRESS SUCTION ← 2ND STROKE
SUCTION EXHAUST POWER COMPRESSION → 3RD STROKE
COMPRESSION SUCTION. EXHAUST POWER ← 4TH STROKE
ARNOLD

A clear idea of the relation between the number of power strokes to the cycle of the engine is furnished by Figs. 4, 5, and 6. In Fig. 4 we have one power area per cycle, corresponding to the single acting engine in Fig. 1. In Fig. 5 we have two power areas per cycle, corresponding to the engine illustrated in Fig. 2, and in Fig. 6 four power areas per cycle, corresponding to the engine illustrated in Fig. 3. Further provision is made for obtaining a constant angular velocity of the engine shaft by the use of heavy fly wheels proportioned to meet the characteristics of the engine.

The performance of the modern gas engine as also that of the steam engine does not even approximate the theoretical by reason of the impracticability of utilizing in the form of kinetic energy all the thermal energy contained in the expansive medium, whether gas or steam. The maximum theoretical thermal efficiency of the gas engine approximates 58 per cent., yet due to the fact that the total expansive energy cannot be utilized, the net efficiency does not exceed a maximum of 26 per cent. This figure is, however, much higher than that possible with the steam engine, which under the best operating conditions rarely exceeds 18 per cent. A typical performance chart of a modern gas engine is furnished in Fig. 7. From this it will be noted that the thermo-dynamic efficiency at full load reaches 25 per cent., and the mechanical efficiency 89 per cent. In this test Pittsburg natural gas was used as fuel, having a calorific value per cubic foot of 1,000 B.T.U.



There are several distinct fuel gases available, suitable for gas engines. These are enumerated below, with their respective calorific values per cubic foot.

	Approx. B.T.U. per cu. ft.	
	Gas.	Mixture.
Natural gas	1000	91.0
Coal gas	650	91.7
Carburetted water gas	600	92.0
Coke oven gas	600	90.0
Water gas	300	88.0
Producer gas	120-145	60-68
Blast furnace gas	90	53.0

By "mixture" is meant the best proportions of mixed gas and air to produce complete combustion in the engine cylinder, and hence maximum transformation of energy.

It will be noted that with the exception of the blast furnace gas, all the calorific ratings of the mixtures are approximately equal. If gases poor in calorific value are used larger cylinders are necessary to accommodate the increased quantity required to compensate for the poorer quality to produce the same amount of energy.

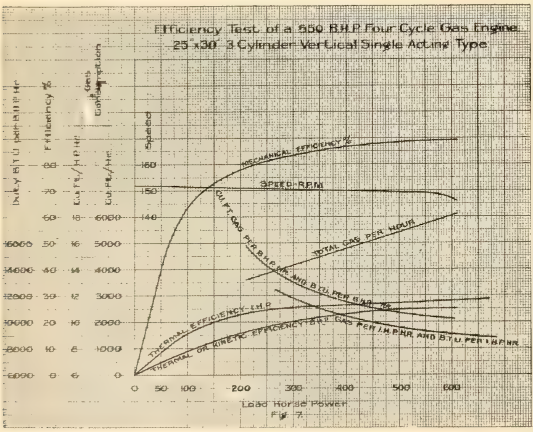
The producer, corresponding to the boiler of a steam plant, and in which the carbon of the coal s transformed to a gas, is of several forms, depending upon the character of the fuel to be used. They are, however, the same in principle. The producer ordinarily consists of three elements; the generator, somewhat similar to a blast furnace on a small scale, a scrubber, for cooling and removing impurities from the gas, and a steam boiler heated by the gas produced in its passage to the scrubber, the steam being necessary for the operation of the generator. A gas holder also forms part of the equipment, by means of which the gas can be stored, acting in this respect as a reservoir.

Producer gas at present offers the greatest possibilities for utilization in gas engines, due to its comparative cheapness and the high efficiency and simplicity of the generating apparatus.

A comparison of the approximate thermal efficiency of the various gas processes are as follows :

Coal gas (without coke)	24%
Coal gas (coke included)	60%
Water gas	60%
Producer gas	80%

Considering now the question of the relative economy of gas and steam engine plants as applied particularly to the generation of electrical power in central stations, we must view the comparison from two main standpoints :

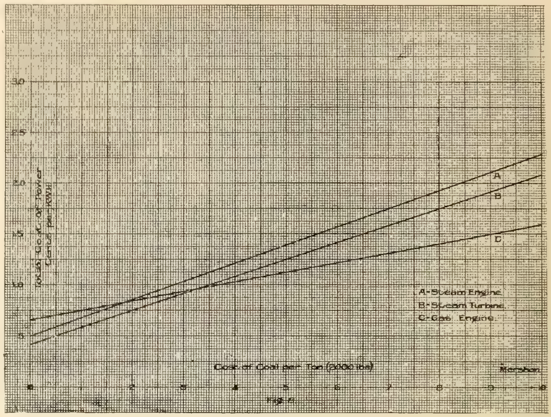


First.—The initial cost and fixed charges of the equipment.

Second.—The cost of maintainance and fuel.

The cost of a gas engine plant, including engine, producer, holder and auxiliaries installed, is approximately from 40 to 50% more than for a corresponding steam engine plant designed for the same maximum output.

The depreciation of the gas engine in practice has not exceeded that of the steam engine, and as the same rates of interest, taxes and insurance, apply to both, the fixed charges of the gas plant will be considerably in excess of those for the steam plant.



The fuel consumption of the gas plant will approximate one-half that of the steam plant for the same output, hence the cost of fuel is the principal factor in determining which investment will ultimately prove more profitable upon a basis of assumed initial cost.

Another consideration which here enters into the comparison is that of maintenence. It is generally admitted by gas engineers that this item is materially higher for the gas than for the steam plant, yet to offset this it is claimed that the standby losses of the steam plant fully compensate for this excess.

The average efficiency of a producer gas plant may be taken as 80 per cent. Assuming a calorific value of medium grade coal as 12,500 B. T. U. per lb., the heat available at the engine cylinder is 10,000 B.T.U. The thermal efficiency of the engine may be assumed as 25%, thus 2500 B. T. U. are utilized in producing kinetic energy in the engine. The thermal equivalent of a horse power is 2545 B. T. U., thus in the case considered the production of one h. p. of kinetic energy requires in the gas plant a consumption of $\frac{2545}{2500} = 1.02$ lbs. of coal.

The mechanical efficiency of the engine may be taken as 88%, thus a duty of $\frac{1.02}{.88} = 1.16$ lbs. of coal per brake horse power hour may be expected from a well designed gas power plant. Instances are recorded where a fuel consumption of as low as .9 lbs. of coal per B. H. P. hour have been obtained from plants utilizing by-products from the producer plant.

The best economy recorded for high-class steam engine plants averages 3 lbs. of coal per B. H. P., but this figure is representative of plants operating under exceptionally favorable conditions.

In the following relative comparison of the economy and ultimate profitable investment for a gas plant and a steam plant we have assumed a consumption of 2 lbs. of coal per k.w. hour for the gas plant and 4.5 lbs. per k. w. hour for the steam plant as representing the results which would be obtained in a 1000 k. w. plant operating under ordinary conditions, with a load factor of 50% for 20 hours per day for 310 days per year.

ASSUMPTIONS.

	Steam.	Gas.
Rated capacity output	1000 Kw.	1000 Kw.
Pounds Coal per Kw. hour	4.5	2
Cost of coal at plant, per ton (2000 lbs)	$3.00	$3 00
B. T. U. per lb. of coal	12500	12500
Average load, 50% L. F.	500 Kw.	500 Kw.
Hours operation per day	20	20
Days per year	310	310
Total hours per year	6200	6200
Depreciation	10%	10%
Interest	5%	5%
Taxes, Insurance, Etc.	2%	2%
Life of Plant	10 years	10 years
Cost of plant installed complete with auxiliaries, based upon a B. H. P. output capable of carrying continuously 25% overload capacity of generators and 50% overload for two hours and 100% momentarily	$100.00	$150 00

EQUIPMENT.

	Steam.	Gas.
Cost of equipment	$100 000.00	$150,000 00
Interest, 5%	$5,000.00	$7.500.00
Depreciation	$10,000.00	$15.000.00
Taxes, insurance	$2,000.00	$3,000 00
Total fixed charges	$17,000 00	$25.500.00
Total fixed charges per kw. capacity	$17.00	$25.50
Excess gas over Steam, per k.w.		$8.50
Excess gas over steam for 10 years, per k.w		$85.00
Excess fixed charges gas over steam, per 1000 k.w. per year		$8,500.00
Excess gas over steam for 10 years per 1000 k.w.		$85,000.00

COMPUTATION.

	Steam.	Gas.
Total k. w. hours per day	10,000	10,000
Total k. w. hours per year	3,100,000	3,100,000
Cost of fuel per k. w. hour	.675 cts.	.30 cts.
Cost of fuel per day	$67 50	$30.00
Cost of fuel per year	$20,925.00	$9,300.00
Saving in cost of fuel for gas plant over steam plant, per year		$11,625.00
Ditto for ten years		$116,250.00
Excess fixed charges gas plant over steam plant for 10 years		$85,000.00
Saving in total cost operating and fixed charges of gas plant over steam plant for 10 years		$31,250.00
Cost of fuel per k. w. per year	$20.92	$9 30
Cost of fuel per k. w. for 10 years	$209.25	$93.00
Saving in fuel cost gas plant over steam plant per k. w. for 10 years		$116.25
Excess fixed charges gas plant over steam plant per k. w. for 10 years		$85.00
Net saving gas plant per k. w. for 10 years		$31.25

From the above computation it will be noted that a saving of $31.25 per k. w. for ten years, the assumed life of the two plants, will be realized. This saving amounts to $3,125.00 per year, which capitalized at 5 per cent. would permit an increased working capital of $62,500.00, or, on the other hand, assuming 17% as the total fixed charges, this amount would permit of an increased cost of $18.38 per k. w. for the gas plant, and still be on a parity with the steam plant.

Viewed from still another stand-point, this saving of $3,125.00 per year might be considered as revenue for the payment of increased dividends.

The ultimate investment for the gas plant from the above computation would appear to be much more profitable than for a corresponding steam plant. As previously stated, this fact is influenced almost entirely by the cost of fuel. To illustrate this point: From the above assumptions and computation, if the fuel had cost $2.19 per ton instead of $3.00, the two plants would be on a parity. In other words, the saving in cost of fuel at $2.19 per ton would just equal the excess fixed charges of the gas plant over the steam plant.

In further connection with this point, we furnish in Fig. 8 curves prepared by Mr. R. D. Mershon, illustrating the relation between the total cost of power per k. w. hour and the cost of coal per ton for a gas engine, steam engine and steam turbine plant. The points at which the Curve C. intersects the Curves A. and B. indicates on the abscissæ the cost of coal per ton at which the steam engine and steam turbine plants would be on a parity with the gas engine plant. These curves are based upon the following assumptions, and curves for individual cases based upon other values must be specially computed.

Maximum peak load 1,500 k. w. load factor 50%. Four generator units each of 400 k. w. operating when necessary at 25% overload. Calorific value of coal 12500 B.T.U. per lb. evaporating in the boiler 7 pounds of steam per pound of coal. Steam pressure 150 lbs., 150° F. superheat. Efficiency of gas producer plant, 80%. Under these assumptions the following figures for performances are taken. Steam engine, 12 lbs. of steam per B. H. P. hour; steam turbine, 18 lbs. per k. w. hour; gas engine, 10,000 B. T. U. per B. H. P. hour.

NIAGARA POWER.

Two generating sets of the Canadian Niagara Power Company's plant at Niagara Falls were set in motion on Monday, January 2, 1905. The units are of 10,000 h. p. each and were speeded up to a capacity of 250 revolutions per minute, the test being perfectly satisfactory. Mr. W. H. Beatty, president of the Canadian Niagara Power Company, turned the wheel that governed the flow of water from the penstock to the turbine, while a number of prominent persons were present in honor of the occasion. The company intend to install eleven units of 10,000 h.p. each, making a total capacity of 110,000 h.p.

The Ontario Power Company and the Electric Development Company are making satisfactory progress with their development work, although their plants will not be completed for some time. It was only recently announced that the Ontario Power Company had made a contract with the Niagara, Lockport and Ontario Power Company to deliver 30,000 electrical horse power to them at the international boundary line at or near the Whirlpool on July 1, 1905, and an additional 30,000 horse power by January 1, 1907. This contract was made for a period extending to April 1, 1950, with renewal rights for 60 years more, or to 2010. Under the agreement the Niagara, Lockport and Ontario Company are to erect a transformer station on the American side near the point of crossing and to construct a transmission line as far as Rochester, N. Y., by July 1, 1905. These contracts indicate that some of the product of the Ontario Power Company will find its way to a market on the New York side.

ELECTRIC RAILWAYS IN CANADA.

Through the kindness of Mr. D. A. Starr, general manager of the Clyde Valley Electrical Power Company, Glasgow, Scotland, we are permitted to publish below some valuable statistics of the electric railways of Canada. The data has been compiled from the Dominion Government reports, but with the details worked out more fully. The returns furnished by the Government are in some cases slightly inaccurate, but those pertaining to traffic are, we believe, as nearly correct as possible. Mr. Starr has for several years prepared similar data, which he has found very useful.

ELECTRIC RAILV

Data of Mileage, Earnings, Expenses, e

		Hull Electric Co'y	Niagara, St Catherines & Toronto	Oshawa Electric Ry	Galt, Preston & Hespeler	Montreal Belt Line	Hamilton, Grimsby & Beamsville	Hamilton Radial Electric Ry
Track Mileage	Double Track	6.85						
	Single Track	15.63	19.94	8.2	9.0	14.10	23.0	12.0
Gauge		4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"
Sidings Length of in Miles		2.	2.15					.50
No. of Junctions with Steam Railways		2	2	1	1	1	1	2
Rolling Stock	Passenger Cars	21	13	9	11	27	9	13
	BM & Express Cars							
	Engines (electric)	1		1				
	Freight Cars		16	3	3	2	8	1
	Snow Ploughs	2	1			2	1	
	Snow Sweepers	1	1	1	1			1
Capital Liabilities	Share Capital (paid up)	$292,000	925,000	40,000	31,310	750,000	200,000	75,000
	Preferred Stock			Bonus 27,400		Bonus 450,000	Bonus 28,000	
	Bonded Debt		594,000	88,452.16			85,000	
	Floating Debt		247,657.05	10,890.81	100,000	52,552.23	10,617	
	Total	$292,000	1,766,657.05	166,742.97	131,310	1,252,552.23	323,617	75,000
Capital Liabilities per Mile of Single Track		$	79,975.42	20,790.89	14,590	88,833.49	14,070.30	6,000
Cost	Railway & Rolling Stock	$749,279.95	1,344,746.68	192,784.29	123,014.91	813,805.36	202,050	101,738.95
	Railway per Mile Single Track	$	60,875.82	24,032.94	13,668.33	57,716.69	8,784.78	8,135.12
Earnings	Passenger Traffic	$47,265.90	63,321.00	7,783.12	18,049.11	43,888.63	44,612.98	43,648.22
	Freight Traffic	$7,789.99	31,392.22	40,337.65	11,225.18	9,273.90	11,266.68	3,069.50
	Mails & Express	$600.00	659.93	2,183.89		500.00	5,180.13	
	Other Sources	$18,293.48	1,313.53	1,619.57	828.35	2,900.86	1,471.85	1,461.26
	Total	$73,949.37	96,686.68	51,934.23	30,102.64	56,563.39	62,531.64	48,178.98
Operating Expenses	Maintenance, Lines, Buildings	$11,997.83	7,985.83	8,476.38	4,777.25	1,069.63	6,815.77	1,935.09
	Working & Repairs to Motors & Cars	$11,074.70	8,899.70	10,188.10	11,639.15	9,520.50	11,122.60	9,751.59
	General Expenses	$36,006.96	53,283.83	16,604.08	9,972.58	16,169.01	13,230.25	12,004.45
	Total	$59,079.48	70,769.36	35,268.56	26,388.98	26,759.13	31,168.62	23,791.13
Nett Earnings		$14,869.88	25,917.32	16,655.67	3,713.66	29,804.26	31,368.02	24,387.85
Mileage	Passenger Trains	388,654	210,462	40,299	72,310	215,764	248,746	199,534
	Freight Trains	15,163	288,000	21,323	12,350	20,124		
	Total	403,817	498,462	61,622	84,660	235,888		
Passengers Carried		705,476	602,035	33,853	289,292	431,953	345,639	581,583
Freight Carried (in Tons of 2000 lbs)		54,452	92,248	66,370	31,058	35,316	6,380	2,400
Earnings	Per Passenger (cents)	6.7	10.52	5.81	6.24	10.16	12.91	7.5
	Per Ton Freight (")	14.31	34.03	60.77	36.14	26.26	176.59	129.9
	Total per Train Mile (cents)	18.31	19.04	84.26	35.55	23.98	25.14	24.15
Expenses, total per Train Mile (cents)		14.63	14.02	57.23	31.17	11.34	12.53	11.93
Passengers carried per Train Mile		1.82	2.86	3.32	4	1.83	1.39	2.91
Freight carried per Train Mile (tons)		3.5	.32	3.11	2.57	.57		
Proportion of Expenses to Earnings		79.89%	73.2%	67.92%	87.66%	47.31%	49.84%	49.38%
Remarks		Water Power	Two Steam Power Houses	Steam Power	Steam Power	Steam Power	Steam Power	Steam Power

		Hamilton & Dundas Electric Ry	Metropolitan Elec. Ry Toronto	Montreal Park & Island Ry	Guelph Electric Ry	Montreal Street Railway	Toronto Railway
Track Mileage	Double Track			12.75		45.78	46.87
	Single Track	7.25	28.0	12.49	5.5	25.09	3.00
Gauge		4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'10⅞"
Sidings Length of in Miles			2	2.3	.33	9.12	5.75
No. of Junctions with Steam Railways		2		4	1	6	2
Rolling Stock	Passenger Cars	4	20	41	8	720	705
	BM & Express Cars		2				
	Engines (electric)						
	Freight Cars	1	5	14		19	3
	Snow Ploughs		1	1		2	2
	Snow Sweepers			2		20	13
Capital Liabilities	Share Capital (paid up)	100,000	450,000	720,900	47,545.53	6,000,000	6,539,690
	Preferred Stock			315,000			
	Bonded Debt	100,000		1,025,000	48,000.00	2,473,333	3,473,373.33
	Floating Debt		550,000	599,947.61	95,545.53	706,175.67	352,650.53
	Total	200,000	1,000,000	2,660,847.61		9,179,508.67	10,365,713.86
Capital Liabilities per Mile of Single Track		27,586.21	33,333.33	67,487.94	16,388.60	72,519.42	101,138.78
Cost	Railway & Rolling Stock	248,906.70	690,905	2,190,580.64	90,927.51	8,470,238.92	
	Railway per Mile Single Track	34,331.86	23,030.77	54,737.14	15,596.48	66,916.09	
Earnings	Passenger Traffic	24,718.68	66,056.97	136,367.85	16,104.55	2,125,480.32	1,987,258.94
	Freight Traffic	1,652.38	6,176.85	2,350.27	954.19		
	Mails & Express	75.35	2,000.00				
	Other Sources	6,661.89	569.27	1,622.90		37,489.35	12,808.40
	Total	33,108.28	74,803.09	140,341.52	17,058.74	2,162,969.67	2,000,067.34
Operating Expenses	Maintenance, Lines, Buildings	6,098.68	8,126.92	22,293.65	3,706.51	167,481.91	57,723.50
	Working & Repairs to Motors & Cars	3,335.88	34,279.74	59,937.58	12,893.88	398,412.92	392,374.49
	General Expenses	8,855.19	2,967.73	50,595.18	284.53	716,040.77	681,828.78
	Total	18,282.75	45,374.39	132,826.41	16,884.92	1,281,935.60	1,131,976.77
Nett Earnings		14,825.53	29,428.70	7,513.11	173.82	881,034.07	868,090.57
Mileage	Passenger Trains	71,638	250,000	720,015	196,200	11,232,924	11,040,257
	Freight Trains		40,000	8,808	550		
	Total		290,000	728,823	196,750		
Passengers Carried		290,904	521,083	1,515,451	380,123	53,077,467	48,619,704
Freight Carried (in Tons of 2000 lbs)		1,230	800	11,438			
Earnings	Per Passenger (cents)	8.5	12.68	9	4.23	4	4.08
	Per Ton Freight (")	134.34	7.72	20.55			
	Total per Train Mile (cents)	46.22	25.79	19.25	8.67	19.25	18.12
Expenses, total per Train Mile (cents)		25.52	15.65	18.22	8.58	11.41	10.25
Passengers carried per Train Mile		4.06	1.8	2.08	1.95	4.72	4.04
Freight carried per Train Mile (tons)			.02	1.3			
Proportion of Expenses to Earnings		55.22%	60.66%	94.64%	99%	59.27%	56.59%
Remarks		Water Power Supplied by Cataract Co'y	Two Steam Power Houses Package Fr'ght Only	Steam Power	Steam Power	Steam & Water Power Rented from Chambly Co	Steam Power

		Ottawa Street Railway	Quebec Rlwy Montmorency Div.	Quebec Rlwy Citadel Div.	Hamilton Elec. St. Ry.	Winnipeg Street Ry	Halifax Tramway
Track Mileage	Double Track	18.28	6.00		10.50	5.00	1.58
	Single Track	5.57	13.00	17.22	1	10.00	6.74
Gauge		4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"
Sidings Length of in Miles			4.50				.55
No. of Junctions with Steam Railways		2	2		1		
Rolling Stock	Passenger Cars	102	10	66	81	76	36
	BM & Express Cars						
	Engines (electric)	3					
	Freight Cars	1		1		1	
	Snow Ploughs			2			
	Snow Sweepers	7		6	2	2	3
Capital Liabilities	Share Capital (paid up)	814,800	1,000,000	1,000,000	205,000		1,350,000
	Preferred Stock		Bonus 402,945.50	212,620			
	Bonded Debt	500,000	1,000,000	500,000	500,000		600,000
	Floating Debt	161,296	112,153.48	112,153.48			
	Total	1,476,096	2,515,098.98	1,824,723.48	705,000		1,950,000
Capital Liabilities per Mile of Single Track		58,036.70	65,257.59	105,968.26	32,045.45		
Cost	Railway & Rolling Stock	1,573,498.31	2,476,915.47	1,159,361.90	970,989.50	1,095,168.06	1,400,000
	Railway per Mile Single Track	37,324.91	83,963.23	67,326.47	44,135.68	54,758.44	
Earnings	Passenger Traffic	328,100.22	82,371.39	186,905.69	180,578.73	230,341.56	143,746
	Freight Traffic						
	Mails & Express	4,000.00	562.53	750.00			
	Other Sources		864.86		3,059.09	1,170.39	578.05
	Total	332,100.22	83,798.78	187,655.69	183,637.82	231,511.95	144,324
Operating Expenses	Maintenance, Lines, Buildings	28,771.79	13,652.06	21,316.29	9,601.64	7,605.06	8,193
	Working & Repairs to Motors & Cars	35,483.48	9,448.34	9,296.31	41,005.18	49,232.08	49,252
	General Expenses	128,022.67	22,184.34	98,909.16	67,354.06	66,463.76	45,096
	Total	192,277.94	50,284.74	129,521.76	117,960.88	123,301.80	102,542.45
Nett Earnings		139,822.28	33,514.04	58,133.93	65,676.94	108,210.15	41,781.91
Mileage	Passenger Trains	2,290,065	176,977	1,179,033	1,190,180	1,196,503	687,819
	Freight Trains						
	Total						
Passengers Carried		7,649,850	666,460	4,424,127	4,353,637	5,341,542	3,204,504
Freight Carried (in Tons of 2000 lbs)							
Earnings	Per Passenger (cents)	4.29	12.36	4.22	4.15	4.31	4.48
	Per Ton Freight (")						
	Total per Train Mile (cents)	14.5	47.35	15.98	15.43	19.35	20.98
Expenses, total per Train Mile (cents)		8.4	28.41	10.99	9.91	10.3	14.91
Passengers carried per Train Mile		3.34	3.76	3.75	3.66	4.46	4.66
Freight carried per Train Mile (tons)							
Proportion of Expenses to Earnings		57.9%	60%	69.02%	64.25%	53.26%	71.05%
Remarks		Water Power	Water Power Rented from Montmorency	Water Power	Water Power Supplied by Cataract Co'y	Steam Power	Steam Power

COMPILED FROM DOMINION GOVERNMENT REPORTS

Work will be commenced the coming spring on a long-distance telephone line between Indian Head and Regina, N.W.T.

HOW TO HANDLE A HOT BEARING.

By a hot bearing is meant when a "well-behaved" journal and bearing begins to get sizzling hot, due to the lack of oil, poor oil, presence of some gritty substance, or sudden non-alignment.

The first thing on the program is for the engineer to be calm and collected and not get excited.

A hot crank pin provided with a centrifugal, center or telescopic oiler: Flood the pin with oil (preferably cylinder oil) as quickly as possible, through the center oiler arm, or telescopic tubes, mingled with water, if water is handy.

If you have an assistant, station him at the throttle immediately. Keep on pouring in the oil and water and keep the engine running. If the babbitt begins to run or fly, you can make up your mind that the oil holes are stopped up with babbitt; then check the en-

AYS IN CANADA

r the Year Ending June 30th, 1903.

St. John, N.B. Electric Ry	Niagara Falls Park & River Ry	Sandwich, Windsor & Amherstberg	Grand Valley Electric Rlwy	Sherbrooke Street Rlwy	Toronto & Mimico Ry	Levis County Electric Ry	Cornwall Street Ry	Sarnia Street Ry	Yarmouth Street Ry	Berlin & Bridgeport Electric Ry	Toronto Suburban	Cape Breton Electric Ry	Port Arthur Street Rlwy	Nelson Tramway	Wesley Park & Clifton	Toronto & Scarboro	Woodstock Thames Valley & Ingersoll	Port Dalhousie St Catherines & Thorold	Internat'nal Transit Co	Brantford Street Ry	Kingston, Portsmouth & Cataraqui	British Columbia Ry
	1143	.5	SEE REMARKS BELOW																			75
12	2.25	22.15	600	7	587	1025	6	450	2	25	8.50	118	76	3	450	507	11,50	682	3.30	7	770	31
4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'10⅞"	4'8½"	4'8½"	4'8½"	4'8½"	4'8½"	4'10½"	4'8½"	4'8½"	4'8½"	4 8½"	4'10⅞"		4'8½"	4'8½"	4'8½"	4'8½"	4'8½"
	.89				.38	.63	.5			LEASED 202		.36	.13			09			.26			
	2										1				2	1		2	1	1	1	1
25	41	29	4	10	11	10	8	6	5	12	6	9	7	2	6	4	7	8	8	12	22	55
	1	1				1																
							1	1													1	
	2	4				1	2			2			2									8
3		2		1			1		1			1										2
2						1	1		1		1								1	1	2	1
500,000	600,000	297,000	800,000	200,000	47,924.00		100,000	41,035	37,500	13,100	80,000	500,000		250,000	50,000	30,563.86	100,000	77,500	150,000	150000	150,000	1,021,999
						100000	100000	30,880				234,000					100,000				50000	1,265,332
675,000	600,000	140,000	240,000	100,000		150,000						8,50,000	115,000	35,000	100,000		91,200	60,000	285,000	125,000	200,000	2,041,972
36,024.17						26,251.07			8,989.56	17,000	80,018	500,000				5,439.08	50,000		17,483.01	46428.99	46,575.43	150,058
1,211,024.17	1,200,000	437,000	1,040,000	300,000	47,934.00	276,251.07	200,000	71,915	46,489.56	30100	160,018	2,084,000		285,000	150,000	36,003.44	341,200	137,500	452,483.01	321,428.89	446,575.43	4,482,361
100,918.68	46,153.85	18,876.89	52,000	42,851.14		25,390.07	30,769.09	15,981	31,744.78	12,040	18,832.10	111,381.58	14,817.10	95,000	33,333.33	14,729.44	29,669.56	20,161.79	•	45,918.41	57,996.82	97,442.03
	971,377.63	452,603.01				285,611.[illegible]	199,578.59	87,362.64	58,374.23	149,916.[illegible]	107,522.40	2,089,162.14	125,119.10	96,980.[illegible]	18,227.78		320,000	90,000.00	308,744.[illegible]	200,029.88	450,229.48	
	37,360.68	19,550.88				26,251.58	30,104.40	19,413.92	29,181.[illegible]	17,204.12	12,649.41	171,806.10	16,186.17	32,326.9[illegible]	17,383.95		27,826.09	13,196.48		28,575.90	58,471.36	
102,154.35	75,425.35	71,205.29	3,399.60	25,000.00	26,478.06	9,685.[illegible]	13,204.[illegible]	18,698.30	7,225.86	23,210.16	17,248.12	24,409.15	23,817.63	4,334.60	18,969.31	17,007.21	19,381.65	18,799.55	24,319.97	11,325.13	27,686.15	373,099.01
	8,790.50		6.40				5,961.03	3,303.03											1,541.53		625.09	18,471.62
		513.05					250.00	688.00		608.92							584.28					4480.00
	17,132.75	11,975.65					250.22	3750.40	2,203.35	329.45		6,740.80	230.71				2,330.25			3011.96	9010.35	1,250.00
	101,348.10	83693.99	3406.00				20,165.38	26,139.82	9,929.21	24,148.53		31,149.95	24,048.34				22,296.18		25,861.50	14,367.09	37,321.59	393,300.63
7,510.49	7,870.64	4,590.80		12,125.00	4,310.23	2,048.55	1,894.75	771.45	803.00	1,084.56	1,545.26	1,407.07	4,070.06	229.22	1691.57	324.81	655.07	1,554.46	280.14			23,001.39
47,849.08	9,414.75	22,739.58	766.00	850.00	3,100.01	3,088.61	6,802.94	393.81	9,228.53	1,763.54	5,931.36	9,653.29	5,605.01	6,071.74	831.64	2415.28	6,163.77	1,019.88	123.96	4,742.10	7,453.82	32,029.92
10,634.44	36,556.18	25,126.04	4841.06	2,700.00	8,866.66	4,376.67	11,769.66	18,446.73	3,372.41	16,379.5	9,213.04	14626.46	6,818.32	11,599.01	7671.86	9231.01	9037.75	8,339.01	23,535.81	7,891.92	20,051.65	217,461.08
65,994.01	53,841.07	52,456.42	5,607.06	15,675.00	16,216.90	9,513.83	20,467.35	19,611.99	13,403.94	19,221.25	16,689.66	23,686.77	16,493.39	17,899.27	10,195.00	11,971.16	15,856.09	10,962.85	23,939.91	12,634.02	28,249.64	272,492.39
36,160.34	47,507.03	31,237.57	2,201.06	9,325.00	10,201.16	174.27	301.91	6,827.83	5,474.73	4,921.18	558.56	5,463.38	7,554.95	13,565.31	8,772.25	5,086.55	6,440.09	7,836.76	1,921.59	1,733.07	9,071.95	120,808.24
521,824	308,449	447,468	13,200		167,269	68,335	181,414	82,632	73,060	94,180	157,438	115,597	108,030	27,905	139,020	172,428	111,456	94,298	12,200	66,456	96,011	1,659,163
	7,640						11,683															45,639
	316,089						493,091															1,704,802
2,341,167	346,560	1,720,377	17,000	550,000	498,507	197,700	244,436	465,175	180,647	548,000	416,854	626,492	509,195	69,893	349,672	425,194	272,214	252,079		318,430	707,824	7,364,289
	38,200						25,236															6,158
4.36	2177	4.14	20	455	5.31	4.9	455	4.2	4	4.23	411	3.0	4.68	6.2	543	4	7.12	746		3.56	3.9	5.06
	23.01						2362															3
19.58	32.06	18.7	258		1583	1418	1044	32.	1359	256	1095	26.95	2226	1553	1364	986	20	1994	21.98	2162	3887	2307
12.65	1703	11.72	42.47		9.73	13.93	1060	23.13	18.35	20.4	10.06	22.22	15.27	64.14	7.33	6.94	14.23	11.63	196.23	19.01	29.42	15.98
	1.1	3.84	1.29		298	289	16	563	247	581	264	542	4.71	25	252	247	244	267		4.79	7.38	444
	5						216															.135
64.6%	53.12%	62.67%	164.62%	62.7%	61.47%	98.21%	101.5%	74.18%	135%	79.62%	96.76%	82.43%	68.58%	412.95%	[illegible]	70.39%	71.12%	58.31%	92.57%	87.94%	75.69%	69.28%
Steam Power	Steam & Water Power	Steam Power	Power Hired from Bradford Rl'wy (now under const'n)	Water Power	Steam Power Rented	Water Power Rented from Chaudiere 3 miles only in operation returns Dec 6 to Jun 30 only	Steam and Water Power	Water Power Hired	Steam Power	Power Rented from Berlin Lighting Comm'rs	Steam Power	Steam Power For Year of Operation	Steam & Water Power	Water Power Rented from Kootenay Power Co'y	Power Rented from Niagara, St Catharines and Toronto Rlwy Co	Steam Power	Steam Power	Water Power	Water Power	Steam Power	Steam Power Hired from Kingston	Steam Power & Water Power

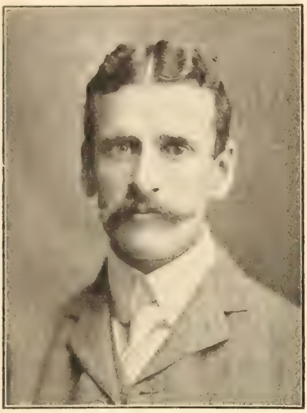
gine down so that "she" just "turns over," follow the crank pin around with an oil can, full of cylinder oil, and get the oil down to the pin by the sides and ends of the brasses. Continue this operation with the engine barely "turning over," until you feel satisfied that the oil has worked in between the pin and the brasses, or until it begins to cool off; then you may stop the engine, take out the brasses, clean the pin with a scraper or smooth file (never use emery cloth or sand paper), clean out the oil holes and passage-ways. If only a little babbitt has run out of the brasses, scrape them down to a bearing surface, using a paste compound of red-lead and oil, smeared thinly over the bearing surface of the pin. By placing the brass that you are scraping on the pin, after the pin has been red-leaded, and moving it around a little, you will find out the high places to scrape down, for the red-lead will rub off the pin on the high points of the brasses. A crank pin brass should only bear or touch the pin in the center of the brass, the full length of the pin.

A hot crank pin that is not provided with a centrifugal, center or telescopic oiler: Slow the engine down immediately, so that it is just "turning over" and that is all. Follow the crank pin around with an oil can and get the oil down to the pin, by the sides and ends of the brasses, until the pin begins to cool off, or that you are satisfied that you have gotten oil between the brasses and pin; then shut the engine down completely and proceed to scrape the brasses as above stated.

In either of the above cases, if the babbitt has not started and the engineer discovers that the pin is beginning to cool off, after he has applied the oil freely, he may fill up his oil cups and speed up the engine to full speed and go ahead with perfect safety.

CANADIAN STREET RAILWAY ASSOCIATION.

Representatives from the leading street railway companies in Canada met at the Windsor Hotel, Montreal, on December 20th last and decided to organize an association. A preliminary meeting had been held some time previous at which a committee was appointed to draft a constitution. This constitution was formally adopted at the organization meeting. It provides that the name of the organization shall be the Canadian Street Railway Association, and that its offices shall be at the place where the secretary-treasurer resides. According to the constitution, the object of the association shall be the acquisition of experimental, statistical and scientific knowledge relating to the construction, equipment and operation of street railways and the diffusion of this knowledge among the members of the association with a view to increasing the accommodation of passengers, improving the service and reducing its cost, and the encouragement of cordial and freindly relations between the roads and the public. The members of the association shall be the street railway companies in the Dominion of Canada, each member to be entitled to one vote by a delegation presenting proper credentials.


Mr. W. G. Ross,
President Canadian Street Railway Association.

The election of officers took place on the second day, when the following were appointed:

President, W. G. Ross, managing director Montreal Street Railway.

Vice-president, W. H. Moore, assistant to the president of the Toronto Street Railway.

Secretary-treasurer, Allan Royce, vice-president of the Toronto Suburban Railway.

Executive committee—C. E. A. Carr, general manager London Railway; E. A. Evans, manager Quebec Railway; D. McDonald, manager Montreal Street Railway.

Attorney, Col. H. H. McLean, K. C., director St. John Railway, St. John, N B.

The following delegates were present at the meeting: W. G. Ross, managing director Montreal Street Railway; Duncan McDonald, general manager Montreal Street Railway; R. J. Fleming, general manager Toronto Street Railway; W. H. Moore, assistant to president of Toronto Street Railway; C. E. A. Carr, general manager London Street Railway; Allan Royce, vice-president Toronto Suburban Railway; E.A. Evans; manager Quebec Railway, Light & Power Company; W. Z. Earle, manager St. John Railway; Colonel H. H. McLean and M. Neilson, of the St. John Street Railway; Dr. S.R. Ickes, treasurer Grand Valley Railway, Brantford; Elmer M. White, cashier Hartford Street Railway, Hartford, Conn.; W. B. Brockway, acting secretary treasurer of the Street Railway Accountants' Association of America, Yonkers, N. Y.; also the following officials of the Montreal Street Railway: L. Trudeau, superintendent; M. Grayburn, master mechanic; R. M. Hannaford, chief engineer; D. E. Blair, superintendent of rolling stock; Patrick Dube, secretary, and H. E. Smith, accountant.

Two papers were read at the inaugural meeting, one by Mr. Duncan McDonald dealing with the relief of traffic during congested hours, and the other by Mr. E. A. Evans referring to the carrying of freight on suburban roads.

NEW STREET RAILWAY MANAGER.

Within the past month Mr. E. H. Keating has tendered his resignation as manager of the Toronto Street Railway and has been succeeded by Mr. R. J. Fleming, who for some years has been Commissioner of Assessment and Property for Toronto. The salary attached to Mr. Fleming's new position is stated to be $10,000 per year.

Mr. Fleming was born in Toronto on November 23, 1854. After receiving a business education, he entered into partnership with Mr. T. W. Elliott in the coal and wood business, subsequently turning his attention to real estate. He was appointed Assessment Commissioner for the City on August 5, 1897.

Mr. R. J. Fleming,
Manager Toronto Street Railway Company.

In municipal life Mr. Fleming has been prominent since 1886, when he was elected as Alderman for St. David's Ward, which he served for four years. In January, 1892, he was elected Mayor of Toronto, defeating Mr. E. B. Osler, M.P., and repeating his success in the following year with Mr. E. E. Sheppard as his opponent. In 1894 and 1895 he was unsuccessful, but in 1897 he again obtained the confidence of the citizens, being elected by 1,800 votes. During his municipal career he fought for and obtained many important reforms in the face of strong opposition, and as Commissioner of Assessment and Property he did yeoman service for the city.

The Toronto Railway are to be congratulated upon securing Mr. Fleming as their manager. His exceptional ability as a business man is admitted on all sides. He is a most vigorous administrator, with a great capacity for work, and as an executive officer has few equals. He is affable, with a pleasing personality.

TORONTO BRANCH A. I. E. E.

The thirteenth regular meeting of the Toronto Branch of the American Institute of Electrical Engineers was held in the Engineers' club rooms, 96 King street west, on Friday evening, January 13th. The subject for discussion was "The Relative Advantages of a 250-500 Volt Three-wire Continuous Current Distribution for the Business Districts of Large Cities," which was introduced by Mr. R. G. Black. For the purpose of comparison and discussion, Mr. Black assumed an ideal condition, namely, a uniformly loaded district. He referred briefly, first, to the different alternating current systems, and, secondly, to the direct current systems, and concluded by advocating the use of the 250-500 volt direct current system. This method of distribution, he said, had been adopted in England and in some of the leading cities of the Unitea States and was giving splendid satisfaction, one of the main advantages being that it permitted the use of storage batteries. An objection could be raised on the ground of the lower efficiency and cost of the 250-volt lamp as compared with the 110-volt lamp, but he believed the manufacturers could soon raise the efficiency and reduce the cost of the higher voltage lamp. That its first cost was greater was largely due to the small demand for high voltage lamps in the past.

An interesting discussion followed Mr. Black's remarks. Mr. C. H. Wright questioned the efficiency of such a system. While the increase of voltage would undoubtedly cut down the cost of copper, it might not satisfy the customer, as the supply of motors from lighting mains would cause excessive fluctuation in the lamp voltage. Mr. W. A. Johnson spoke in favor of the direct current system, especially when the advantages of operating storage batteries were considered. He believed there were many advantages in reaching the lamp direct from the machine, be that machine the generator, the rotary, or the storage battery.

Mr. H. A. Moore said that alternating current plants had been installed in many cities and towns where they were not suitable, and that engineers when estimating on alternating systems in many instances did not appreciate the large investment necessary in secondary mains, transformers, etc., and the losses incidental to transformation and secondary transmission. The alternating current system had been carried too far ; for distribution in the business districts of cities he strongly favored the direct current system. He had in many instances recommended the raising of two-wire 125-volt systems to two-wire 250-volts, and the results had been satisfactory. A 250-volt system was in successful operation in Berlin, Ont.

Messrs. MacKeen, Aitken, Walker, Albert, and others took part in the discussion, which seemed to suggest the more general adoption of the direct current for city distribution within defined areas in the near future.

PUBLICATIONS.

One of the handsomest calendars received by the ELECTRICAL NEWS bears the compliments of the National Carbon Company, of Cleveland, Ohio. It is a combined calendar and moonlight schedule.

"Trucks for Motor Cars" is the title of the latest bulletin received from the Canadian General Electric Company, who recently acquired the sole right in Canada to manufacture and sell Curtis trucks.

The Rhodes Electrical Manufacturing Company, 70 Bishopsgate St. Within, London, England, have sent us one of their new lists of R.E. type motors, giving particulars of the output of their different frames at various speeds, also prices and approximate shipping measurements.

Bulletin No. 1, issued by the I. P. Morris Company, of Philadelphia, contains some excellent illustrations of turbine machinery installed in the plants of the Niagara Falls Power Company, the Canadian Niagara Power Company and the Shawinigan Water & Power Company. This company are prepared to install complete steam or hydraulic plants.

The Christmas Greeting and January Calendar of the Pittsburgh Transformer Company was one of the nicest bits of holiday printing which reached this office. The company advise that they expect to make the Pretty Girl Calendars for 1905 even more attractive than they have been during the past two years. Any electric light or power company not receiving them will be added to the mailing list upon request.

The book entitled "Petrol Motors and Motor Cars," by T. H. White, A.M.I.M.E., and published by Longmans, Green & Company, 39 Paternoster Row, London, England, has been written largely from the designer's point of view and is intended to provide designers and draughtsmen with reliable formulæ and information, in a readily accessible form, on the subject of internal combustion engines. The price of the book is 4s. 6d.

The most complete and useful diary for electrical people which has yet come to our notice is that bearing the compliments of the Westinghouse Electric & Manufacturing Company. Besides its convenient arrangement as a diary, it includes about 40 pages of valuable engineering information which cannot fail to prove of great assistance to all persons engaged in engineering. It is neatly bound in leather.

Two catalogues recently received from Messrs. J. H. Holmes & Company, Newcastle-on-Tyne, England, are of interest. They refer to the Holmes-Page patent switches, of which they are the sole patentees and manufacturers, and their recording voltmeters and ammeters. Their switches have high conductivity, superior finish, quick and wide break and self-adjusting contacts and have an unusually large surface area in proportion to the current to be carried. Their instruments possess features of novelty which distinguish them from the ordinary type of recorder at present in general use. The difficulty of driving a continuous band of paper has been overcome by the use of a serrated driving wheel acting on the centre of the paper band.

PERSONAL.

Mr. Ormond Higman, jr., B.Sc., has been appointed superintendent of the Berlin gas and electric lighting plants, Berlin, Ont.

It is announced that King Edward has conferred a knighthood upon Prof. Joseph Wilson Swan, president of the Faraday Society, London, England, and inventor of the incandescent electric lamp bearing his name.

Mr. Cecil B. Smith recently tendered his resignation as resident engineer of the Canadian Niagara Power Company and has again established himself as a consulting and constructing engineer at 36 Toronto street, Toronto. He has been succeeded by Mr. A. H. VanClive.

Mr. George White-Fraser, who is well known to the electrical fraternity in Eastern Canada, and who has been in the Yukon district for some years, has, we understand, been given the electrical engineering on one of the Government railways to be built in the northern region.

Mr. William Thompson, M.E., recently manager of the Velvet-Portland and Rossland-Kootenay mines, at Rossland, B. C., has gone to Mexico to take charge of the interests of the Waterson Gold Mines, Limited, at Ocampa, but remains as consulting engineer with both Rossland companies. Before his departure he was presented by the Rossland Club with a casket of silverware.

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ADVERTISEMENTS.

Advertising rates sent promptly on application. Orders for advertising should reach the office of publication not later than the 28th day of the month immediately preceding date of issue. Changes in advertisements will be made whenever desired, without cost to the advertiser, but to insure proper compliance with the instructions of the advertiser, requests for change should reach the office as early as the 26th day of the month.

SUBSCRIPTIONS.

The ELECTRICAL NEWS will be mailed to subscribers in Canada, or the United States, post free, for $1.00 per annum, 50 cents for six months. The price of subscription should be remitted by currency, registered letter, or postal order payable to the C. H. Mortimer Publishing Company of Toronto, Limited. Please do not send cheques on local banks unless 25 cents is added for cost of discount. Money sent in unregistered letters will be at senders' risk. Subscriptions from foreign countries embraced in the General Postal Union $1.50 per annum. Subscriptions are payable in advance. The paper will be discontinued at expiration of term paid for if so stipulated by the subscriber, but where no such understanding exists, will be continued until instructions to discontinue are received and all arrearages paid.

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Subscribers are requested to promptly notify the publishers of failure or delay in delivery of the paper.

EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

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Treasurer, J. M. DIXON,	Toronto, Ont.
Conductor, W. OUTHWAITE.	Toronto, Ont
Door Keeper, E. GRANDBOIS	Chatham, Ont.

British Standardization. Not many years ago a fairly large manufacturer of electrical apparatus in the United States built up for himself a very comfortable export trade, his complete foreign shipments going almost entirely to England. As time passed, he established an agency in the Old Country, and this step led to a very material increase in his business. But there was one feature of the arrangement which bothered him. His staff of designers had to be greatly increased. To a certain gentleman he confided his trouble, and in explanation, took him out to the testing department. "Look," he said, "at that twenty horsepower motor—wound for 165 volts. Here is another one—92 volts. And last week we shipped a large machine that was wound for 345 volts. What do you think of that? I write my agent that if he can secure orders at my standard voltages of 110, 220 and 500, the price of the machines will be reduced very greatly, and he replies, 'but you know, my customers do not want the voltages that you mention—their generators are not wound for them.'" There, in a nutshell, we have the reason why the electrical business in the Western Hemisphere has made such enormous strides—everything has been built on adopted standards, and the cost of manufacture has accordingly been lowered. But in England, when a plant was to be installed, the size of the generator was specified, and the manufacturer built a machine for an approximate voltage, which, should it operate better at an increased or decreased pressure, was rated accordingly. Hence, no two plants used motors and lamps of the same potential—each had to have its supplies specially made. Before us now, however, we have a copy of the interim report issued by the British Standardization Committee, and note with great satisfaction that the absurdity of the above mentioned practice has been realized, and is about to be remedied. The standards coincide to a great extent with those adopted on the American Continent, the material difference being that a frequency, for alternating current work, of 50 cycles per second has been decided upon, against 60 cycles as used here. This is considered the standard frequency, while a secondary standard of 25 cycles has also been incorporated. The interim report makes interesting reading, and we look for the complete document with pleasant anticipation.

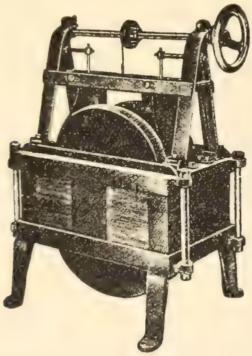
Current Theft. In our last issue we referred briefly to the arrangement adopted by the Montreal Light, Heat & Power Company to counteract the desire of some members of the public at large to obtain something for nothing ; in this particular case the something being electric current. That meters are tampered with, and thus made to register a lower number of watts than actually passes through them, is a well known fact, but so far few, if any, schemes have been devised to properly and effectively combat this evil practice. No matter what the plan may be, there is always the risk of making a mistake, and the result of such mistake is always more or less serious in character from the view point of the electric company. A lost law-suit, or a false arrest, will, where the defendant has sufficient backbone, result in a counter-suit, to say nothing of the unfavorable light in which the supplying company is placed. This latter point is probably the one which appeals to the central station manager with greatest force, for friendly relations with the public is his chief desire, the success of the company hinging directly on this condition. The Dominion Government has done all in its power to protect the central station company from current theft ; in illustration of this, we quote from the Electric Light Inspection Act of 1894 :—"Every person who knowingly repairs or alters, or causes to be repaired or altered, or knowingly tampers with or does any other act in relation to any stamped meter, so as to cause such meter to register wrongly, or who prevents, or refuses lawful access to any meter in his possession or control, or obstructs or hinders any examination or testing authorized by this Act, shall incur a penalty not exceeding one hundred dollars and not less than fifty dollars, and shall pay the fees for removing and testing, and the expense of purchasing and fixing a new meter : Provided that the payment of any such penalty as aforesaid shall not exempt the person paying it from liability to indictment or other proceeding to which he would otherwise be liable, or deprive any other person of the right to recover damages against such person for any loss or injury sustained by such act or default." It is upon this clause that the Montreal Light, Heat & Power Company base their system, for as their charter gives them the right to impose fines in cases where theft of current is detected, the guilty customer, rather than face the court, pays the fine, and, as it were, is given a new start. The meter inspectors keep a close count of the lamps or motors in each building, and knowing, in a general way, the probable current consumption, a check is thus made, and in the event of a deficit, an investigation results. As before noted, great care and diplomacy are needed in carrying out such a scheme, but from reliable sources there comes to us advice that so far, in Montreal, the idea has been very successful.

Real Electric Fires.

From time to time comment has been made in these columns on the subject of fires of unknown origin, which have been charged, without rhyme or reason, to the electric equipment of the building destroyed. In almost every instance these remarks have followed closely upon the receipt of information through the medium of either the lay press or the insurance people, and have invariably been caused by the absurdly unfair light in which the electrical public has been placed. In our issues of last February and last December, we called attention to the matter, and having taken a definite stand, shall continue to do so until the unjust practice is stamped out. As admitted in our preceding number, a certain percentage of these fires can properly be laid at the door of electricity ; but it is doubtful whether in such cases the real cause of the fire is understood. Defective or damaged insulation is one cause ; the old style open fuse-block is another ; and as a third we have the ordinary incandescent lamp—not broken, or in the act of breaking, but intact. It is with this last risk that we intend to deal in this number, for it seems to be the general opinion of even electrical men that the incandescent lamp gives out very little heat, and that its fire producing tendencies are therefore negligible. The heat from the filment of a lamp with a good vacuum reaches the glass but slowly, and consequently the radiation is usually sufficient to keep the external temperature down to a fairly low point ; on the other hand, when the process of exhausting has not been properly carried out, the lamp soon gets to a point which will not permit handling without a glove. Even in the case of a good lamp, when the radiation is hindered in any way, such as by a surrounding medium, the temperature will rise with great rapidity, which puts the good lamp on a par with the poor one, so far as fire risk is concerned. Numerous tests have been made to ascertain the action of burning lamps on materials of various description, and reference to some of them will no doubt be found of interest. In all cases the lamps used were picked at random, no attempt being made to select either very good or very poor lamps, and the results should lead to the use of greater caution when putting up decorations in connection with lights. In one case, where a lighted lamp rested against a vertically placed white pine board, a spot, about an inch in diameter, and of a light brown color, appeared after about four hours. When a strip of well-seasoned, varnished oak was substituted for the pine, the varnish became blistered in three minutes, and blackened in about fifteen. The wood near the point of contact had the appearance of being charred, but was not ignited. With a lamp incased in two thicknesses of muslin, the latter became scorched in one minute, in three minutes gave off smoke, and at the end of six minutes, when the muslin cover was removed and fresh air reached its interior, it burst into flame. When a lamp was laid on inflammable material, the action seemed more rapid, due, no doubt, to the pressure exerted by the weight of the lamp. A newspaper was, in this way, carbonized in three minutes, and ignited in forty-five. When a 16 candlepower lamp was immersed in half a pint of water, the latter boiled within an hour. Again, with a lamp buried in cotton wool, the wool soon scorched and ultimately burst into flame. A lamp in contact with celluloid fired it in less than five minutes. Another risk is to be found in connection with flexible cord. Cases are on record where short-circuits developed in the drop cords of lamps which were turned off, and although the fuses in the circuits blew instantly, the heat of the momentary arc was sufficient to ignite the insulation of the cord. In one instance the drop, being in a cotton mill, was saturated with oil and covered with lint, and a serious fire quickly developed. There are numerous other cases of similar nature, which could be cited, but their bringing forward is rather beyond the scope of the present discussion. It unquestionably produces a pleasing effect to drape lamps with colored hangings, and to carry out a scheme of decoration conceived along such lines ; and there is no reason at all why this should not be done, always provided that possible fire risks be borne in mind, and the work carried out in a common sense way. It would be a difficult matter to state with accuracy how much the general risk, with things even as they are, has been lowered by the advent of the incandescent lamp, but we are absolutely certain that this lowering has been very great, and that when fires occur, they can be directly charged to gross carelessness. The incandescent lamp, as it stands to-day, cannot be equalled by gas, or coal oil, or candle, or any form of artificial illumination, from the viewpoint of safety and convenience. That it has its risks we are free to admit, but when doing so, to be conscientious, we must state positively that compared to any type of lamp using an open flame, the risk of the incandescent is so infinitesimal as to be unworthy of consideration.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Transformer for Thawing Water Pipes.—In order to meet the demand for a special type of transformer suitable for thawing out broken water pipes, the General Electric Company, of Schenectady, N. Y., have placed upon the market a distinctive style of apparatus, which is shown in the accompanying illustration. The outfit has been designed to withstand rough handling and outdoor service. It is compact and, at the same time, all parts are accessible. Adjdstments over wide ranges of both secondary voltage and current are readily made, and the outfit is simple to handle, portable and comparatively inexpensive. The transformer is designed to operate on circuits varying from 2,000 to 2,300 volts, sixty cycles, and its secondary voltage and current may be readily adjusted from zero to seventy-five volts and zero to 400 amperes by means of an adjustable cord or flux shunt controlled by a handwheel and locking devcie. The outfit complete, including transformer, switches, cover and meter, weighs approximately 1,200 pounds. It is mounted on four broard, flanged wheels, to permit its being quickly loaded on a wagon bed or sleigh. The space occupied by the transformer is about twenty by thirty inches, with a height of thirty-six inches.



TRANSFORMER FOR THAWING WATER PIPES.

New Type of Oil Fuse.—Exhaustive tests were recently carried out at the works of the Lahmeier Company, Frankfort-on-the-Main, Germany, with a view to determining a suitable type of high-voltage fuse. The first attempts were made with a fuse submerged in oil, which gave satisfactory results up to tensions of 10,000 volts; but the explosion caused by the melting of the fuse was considerable and tended to scatter the oil. A satisfactory fuse of this type requires such a large volume of oil as to make it commercially impracticable. It was also found that the cooling effect of the oil on the fuse made the latter unreliable. It was, therefore, decided to try a device in which the fuse proper was not submerged in oil, but in which oil was used to extinguish the arc after it had been formed. The device consists of a glass cylinder with terminals at the top and bottom. The fuse proper is placed within an inverted cup of insulating material. This cup is closed at the top and open below, and is placed partially submerged in the oil, though the latter can not come in contact with the fuse. Contact is made with the fuse by a clamp at the top, with two flexible copper wires attached to its lower extremity, and passing down to the socket at the bottom of the glass tube. There is also a spiral spring attached to the lower end of the fuse. When the fuse is melted, the spring draws it down under the oil. At the same time, the vapors are forced out at the bottom of the cup through the oil. This cools them and extinguishes the arc. This construction is found to give satisfactory results. A circuit may be fused so that it will carry its normal load indefinitely. It will carry continuously an intermittent overload of fifty per cent. It will carry an overload of eighty per cent. for five minutes, and melt in less than two minutes if the load be doubled.

Westinghouse Oil Circuit Breakers.—The Westinghouse Electric & Manufacturing Company have begun the active sale of a new automatic oil circuit breaker of especial merit, adapted to the most modern system of distant control and designed for voltages from 3,300 to 25,000. The circuit-breaker is made in single-pole units, each being mounted apart from the switchboard in a brick or concrete compartment. Two, three and four-pole combinations are made by placing the units side by side. The base of each unit is of treated soapstone and holds two heavy porcelain insulators which carry the stationary contacts and the connection to the external circuit. The movable contacts are at the ends of a U-shaped metal casting fastened at the center to a rod of treated wood, which is moved up and down by the operating mechanism in closing or opening the circuit. The final arc on breaking the circuit is taken by an arcing tip which may easily be replaced.

A Novel Synchronous Converter.—An interesting method of connecting in concatenation an induction motor with a synchronous motor or rotary converter, forms the substance of a patent issued October 18, 1904, to O. S. Bragstad and J. L. La Cour. The frequency of the current in the secondary of an induction motor varies directly with the slip, and at one-half synchronism it has a value equal to one-half of the circuit frequency. By driving the moving member of a synchronous motor mechanically with the rotor of an induction motor and connecting the secondary windings of the induction motor to the armature of the synchronous machine, the set will synchronize at one-half speed. The inventors propose to use as synchronous motor a rotary converter which can deliver direct current to an external load and to its own field windings. This arrangement allows the converter to be operated at one-half the circuit frequency, which condition of operation is conducive to improved commutation as compared with direct transformer connection to the supply lines, while the machine may readily be placed in use from the alternating-current side. The primary of the induction motor may be wound for the high line e.m.f., thus eliminating the need of additional transformers.

In comparison with an induction motor-driven, direct-current generator set, the combination is much less expensive, due to the fact that the motor here required need be of but one-half the capacity of the load, since only this amount of its energy is delivered mechanically, the remainder being given off through transformer action, and also to the fact that a synchronous converter is more economical in material than a direct-current generator of the same output.

Phase Transformation. — Alexander D. Lunt, of Schenectady, N. Y., has devised a method of transforming three-phase current into 12-phase current, or the reverse, which should be useful in connection with rotary converters in which the armature heating is less the greater number of phases there are on the alternating-current side of the machine. In practice Mr. Lunt makes use of three transformers, each of which is provided with one winding connected to the three-phase system and three other windings connected to the 12-phase system. In all these are nine windings connected to the twelve-phase system, and these windings are so inter-related that their electromotive forces may be represented by a double delta superposed upon a double Y. The phase transformation is performed, preferably, by a set of transformers having primary windings differing in number from the secondary windings.

STATEMENT OF FACT.

The only true measure of the normal capacity of a properly designed generator is the current it will develop safely under short circuit with normal (fully excited) field within a (stated) temperature for a given period of time, the maximum capacity being the current at safe temperature under fully saturated field, short circuit to be applied when the generator is giving out its standard voltage, and the same test should be made on all direct current motors and synchronous alternating motors, by operating them as generators.

Purchasers of electrical machines should insist on these requirements if they want an absolute test. W. A. JOHNSON.

Toronto, Can., Dec. 8th, 1904.

TRADE NOTES.

The Richmond Conduit & Manufacturing Company, of Toronto, have furnished the ELECTRICAL NEWS with a combination desk calendar and thermometer.

We are indebted to the Canadian Heine Safety Boiler Company, of Toronto, the Stuart Howland Company, electrical supplies, Boston, and the Waterous Engine Works Company, Brantford, Ont., for calendars for the current year.

The Pittsburgh Transformer Company report that a surprising demand for pipe thawing outfits is making itself known. A considerable number of electric light plants have written that they used electric thawing for some little time past, and in every case the work has been successful. In a few instances there was no profit in the work on account of the fact that the makeshift appliances available rendered the job slow and expensive. The thawing outfit made by the Pittsburgh Transformer Company is said to be the simplest, cheapest and most rapid working device at present on the market.

The attention of young men is directed to the courses of instruction in technical subjects announced in the advertisement pages of this paper by the International Correspondence School, Scranton, Pa. Full particulars regarding any of these courses will be furnished free of charge to any who may write same mentioning this journal.

The Pittsburgh Transformer Company are desirous of securing the names of companies contemplating the transmission of power or who expect to make extensions to an already existing transmission. To those who will write for these, the company will send full data on their line of power transformers with very complete illustrations of the same. The company state that their improved facilities enable them to put out this line at prices which will interest anybody who is in the market. Extremely substantial construction, graceful design and high electrical efficiency are claimed for these transformers.

Edward E. Cary, of Montclair, N. J., who is well known to the electrical fraternity of Canada, has been appointed representative for the United States and Canada for Joseph Sankey & Sons, Limited, Bilston, England, makers of the "Lohys" brand of non-aging sheets and stampings for all kinds of electrical machines. In a paper by Mr. W. N. Mordey, the great English transformer expert and builder, read before the British Association at Cambridge last year, he refers to the product of this firm in the following words: "The only manufacturers to take up this specification energetically were Messrs. Sankey & Sons, of Bilston, with whom an arrangement was made by which the price paid them was increased or reduced as the iron showed less or more than the standard loss. A few pounds of iron were tested in this way out of each delivery, and the corresponding bonus or penalty ascertained. The result was that within a year large variations of loss had ceased, and it soon became possible to design transformers with something like certainty as to what the magnetizing losses would be. This improvement in quality and regularity which affected the whole industry is mentioned here because it is not generally known how much is due to the efforts of these manufacturers."

BOILER INSURANCE.

The value of boiler insurance is being constantly brought to the attention of steam users by the liberality of the Boiler Insurance Companies. Not only is the manufacturer covered against the hazard of loss resulting from an explosion to his steam plant, buildings and storehouse, mill or factory, but the regular and systematic inspection of his steam plant is a service that, were he not insured, would have to be bought.

The Canadian Casualty and Boiler Insurance Company have set a high standard of boiler inspections. The inspections of this company are regularly and periodically made by competent inspectors under the direction of the company's chief engineer, whose personal attention, we understand, is given to all reports sent out and each visit is fully reported. These reports cover not only the condition of the boiler, but also recommendations as to their efficiency, including suggestions to prolong their life and usefulness. This Department also furnishes general steam engineering advice, covering plans and specifications for boilers, engines, steam heating plants and electric lighting equipment, also the adjustment of engine valves, measurement of power, steam or electric, and the valuation of machinery or any technical information their clients may require.

We are glad to learn that the Canadian Casualty and Boiler Insurance Company have found a place which, in the interest of all steam users, is regarded as prominent on account of the service they render through their Consulting Engineers' Department.

MOONLIGHT SCHEDULE FOR FEBRUARY.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Feb. 1	5 40			12 35
2	5 40	Feb. 2	6 15	12 35
3	5 40	3	6 15	12 35
4	5 40	4	6 15	12 35
5	5 50	5	6 15	12 25
6	5 50	6	6 15	12 25
7	5 50	7	6 15	12 25
8	5 50	8	6 15	12 25
9	5 50	9	6 15	12 25
10	10 00	10	6 15	8 15
11	10 50	11	6 15	7 25
12	11 45	12	6 15	6 30
14	0 45	13	6 15	5 15
15	1 45	14	6 00	4 15
16	2 40	15	6 00	3 20
17	3 30	16	6 00	2 30
18	No Light	17	6 00	
19	" "	18	No Light	
20	6 00	19	" "	2 30
21	6 10	20	8 30	3 35
22	6 10	21	9 45	4 50
23	6 10	22	11 00	6 00
24	6 10	24	0 10	7 05
25	6 10	25	1 15	8 10
26	6 20	26	2 20	9 00
27	6 20	27	3 20	9 55
28	6 20	28	4 15	10 50
		Mar. 1	5 10	
		Total............		211 50

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QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All inquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

Ques. No. 1.—(a) What is the formula for getting the pull or tractive effort on a pair of static vanes, with a potential difference of from fifty to three hundred volts? (b) What amount of heat would be required to raise a column of mercury one-half inch in diameter and six inches long a distance of one inch?

Ans.—Neither of the above questions can be considered of "general interest," as each applies to theoretical propositions which practically none of our readers will find of value. In this instance, however, we are answering the queries. (a) This question evidently pertains to the method of calculating the pull between the vanes of an absolute electrometer. The instrument consists of two parallel insulated metal plates, the bottom one being fixed, and the top being divided into three sections. Of these three sections, which are in electrical connection, the two outer ones are stationary, and the centre one is hung at the end of a balance-beam. Calling the large stationary plate A, the two outer upper plates BB, and the centre upper plate b, we have the equation :—

$$\frac{1}{F} = \frac{720{,}000\ p\ d^2}{b\ E^2}$$

where F is the downward pull on b in dynes, p is 3.14159, d is the distance apart of the plates in centimeters, b is the area in square centimeters of the movable plate b, and E is the electromotive force applied to the plates. (b) We presume that in this question, the amount of heat required to *expand* the mercury is desired, and that the column is circular in cross-section. The coefficient of cubical dilatation of mercury in glass is .000158 per degree C., and that of glass (linear dilatation) is .0000086. Therefore, we can assume that the coefficient of the mercury alone is .00015. This holds good between 0°C and 100°C, and we will therefore use this figure. For temperatures above 100°C the coefficient is somewhat higher, but we have no accurate figures at hand. An expansion of one inch equals an increase in volume of one-sixth, and consequently the final temperature of the mercury will be 1111°C. The specific heat of mercury being .033, and the weight of the column referred to being .576 pounds, to produce the expansion mentioned would require 37.95 British Thermal Units. This, of course, assumes that no heat would be lost by radiation, and also assumes that the mercury could be raised to the proper temperature without being vaporized. We would call your attention to the fact that mercury boils at 662°F. and while it has been raised to a temperature of 900°F. in thermometers having compressed nitrogen in the tube, we conclude that it is not possible to devise any means whereby the temperature needed in your question could be reached.

Ques. No. 2.—Do you know of any practical method of locating a grounded armature coil in a three phase revolving field type generator? The ground is such that it is not registered by the ground detector until the voltage comes very near to normal.

Ans.—If you are sure that the ground is in the armature, and not out on the line, nor in the cabling in the power house, the easiest, quickest, and most satisfactory way of locating the fault is by means of burning it out. This is assuming that you have A.C. of both 110 or 220 and 1100 or 2200 volts. Disconnect the leads at the machine running to the switchboard. Take any small transformer and connect the high voltage side to the proper voltage in the power house, and one lead of the low side to the frame of the grounded generator, and the other lead to the winding. In the low potential side of the transformer there should be a double pole switch and a small fuse. Close the switch, and the fuse will probably blow, a flash showing at the point where the armature winding is grounded. This operation may be repeated until the fault is definitely located, care being taken not to burn the insulation too much. If the ground is not indicated in this way, connect the low side of the transformer to its proper voltage, with the switch and small fuse in circuit; connect the high side for 1100 volts, and attach one lead to the frame, and the other to the winding. If the fault is not then located, change the connection to give 2200 volts. If the fuse does not blow and the fault cannot be found, it is no doubt so trifling that it can be passed. We assume that you wish to locate the ground with the idea of making an immediate repair. If the grounded machine is the only one you have, the test may be tried with the exciter, taking care to use a very small fuse. If a magneto will ring through the ground, one section of the winding can be separated at a time and tried, and should it show a ground, then subdivided and tried again, and so on until the fault is localized in the particular coil in which it exists.

Ques. No. 3.—I would be pleased to have your suggestion, and that of any reader of the Electrical News, as to how I can best apply electrical power to maintain steam in a sixty horsepower return tubular boiler. The device must be such that it may be regulated, and in the event of it being insufficient, fuel may be used to assist. The boiler generally has little work to do, but at any time may have work equal to thirty or forty horsepower for a short period. Alternating current at 550 volts is at hand, which could be transformed to any required voltage. Economy of current is no consideration.

Ans.—In a certain town in the West, where there was unlimited electrical power, and where fuel of any kind could be obtained only at a prohibitive price, an electrically operated boiler has been used with some success for heating purposes. This boiler is about fifteen horsepower capacity, and carries a pressure not exceeding twenty pounds. It is a plain steel shell, having no tubes of any kind, and inside, a vast number of iron wire coils mounted on porcelain insulators. We have communicated with the makers of this boiler, and in their reply they give no information of any kind, practically indicating that they do not wish to undertake the construction of a similar device. So far as we know, the number of watts required by the boiler was very high, probably far above your idea when you say "economy of current is no consideration." It is satisfactory only for the reason given above, namely, that it furnishes heat, where, were it not for this scheme, no heat could be obtained. In any event, we do not think you could get a proper working contrivance in which the electric power could be supplemented by either coal or wood, for the boiler being without tubes, would have a very low economy under these conditions.

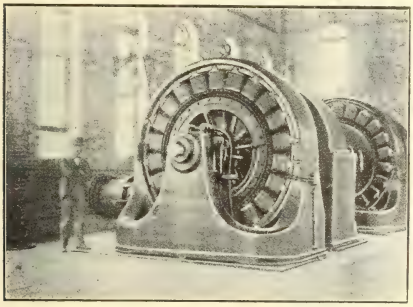
THE INSTALLATION OF A TRANSMISSION PLANT*.

By A Road Engineer.

The Story of an Early Power House, Some Rotary Converter Kinks and Some Telephone Troubles.

It was late in the fall about eight years ago when I arrived at one of the principal cities of the West. An electric transmission system was in course of construction with a power house newly built at the foothills of the mountains some thirteen miles away and a rotary converter sub-station located in the city itself. I had been detailed to superintend the installation of the apparatus for the transmission system, which was a comparatively new piece of work in those days.

I had been through the old student course at Pittsburg and had gotten some little outside experience, just about enough to make me a little nervous over the outcome of my trip. For no matter how long you have been on the road, each new job is found to be different from the others you have done. It is often some engineering feature not foreseen in the laying out of the plant, or some operating condition not duly appreciated, or again it happens that the proper facilities for doing the work are not at hand. Indeed enough uncertainties are always present to arouse in one the liveliest interest and no man can foresee just when he will encounter some problem which will test his metal to the uttermost. And I had a premonition that perhaps this job was mine. I already knew that there were some engineering features about this plant, common enough now-a-days, but unusual enough at that time to arouse my liveliest anticipation.

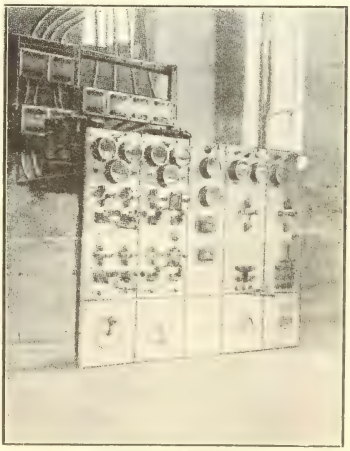


Interior of Power Plant, Showing the 750 K. W. Alternator.

This particular plant was laid out for three 750 kw. generators, but only two were to be installed. They were 60 cycle three-bearing machines arranged to have an impact water wheel mounted on the shaft just where a pulley would be placed if the machine were to be used with a belt drive. Two exciters were furnished, each mounted with a water wheel similarly to the generators. A switchboard, two banks of two-phase, three-phase transformers for stepping up to 15,000 volts, some high tension bayonet switches and type R lightning arresters completed the power-house equipment. The transmission was thirteen miles and at the receiving end were two 400-kw., 550-volt, 18-pole rotary converters. These converters were the largest that had yet been built for 60 cycles. Indeed few of any size were then in service. The local company had been recently organized and was not yet operating. It had no electrical engineers in its employ and only one employe, a lineman, had ever done any electrical work. The company was to furnish all necessary labor and the manufacturers of the electrical apparatus were to lay out the system and superintend the installation.

The first generator had been shipped some time previous to my arrival and had already been hauled across country from the railroad and was lying at the power house in the mountains, much the worse for its trip. The men who had contracted to do the hauling had not a sufficiently stout wagon to carry the heavy generator weights and the wagon with the armature had broken down, ruining a considerable portion of the bar winding and end connectors. The first thing to be done, therefore, was to determine what material was needed for repairs and write out an order for the local company to send to the manufacturer. In situations such as this, where the work is done many miles from any kind of a shop, it is quite essential that the road man be prepared to work with his own hands as well as to superintend, and if he have a well-equipped tool chest it facilitates the work very much. I had use for mine when that winding came.

The location for the switchboard and the station wiring had been laid out by the manufacturing company, but on arriving at the plant I learned for the first time that a separate building had been provided by the local company for the raising transformers. It was in such a location that the plans for the switchboard and the station wiring would have to be changed. As usual, no provision had been made in the construction of the power house for putting any wiring into it at all. There was, therefore, no difficulty in changing the proposed location, and I gave instructions to the local company for the building of a suitable wiring conduit. This was put in at once.



The Switchboard.

The transformer house had been built without any provision for high tension switches or lightning arresters. It was only after considerable planning and a sacrifice of desirable head room that I arranged to have a second floor built in it, which permitted the installation of the apparatus. It was a very cramped position, but it was absolutely needed.

As the engineer was to stay at the plant until it was put in operation, it was advisable, in order to save time, to assemble the water wheels and their governing mechanism. While this did not prove to be a difficult task, it was an eye-opener. I got some experience in handling machinery which was new to me and a little out of my line.

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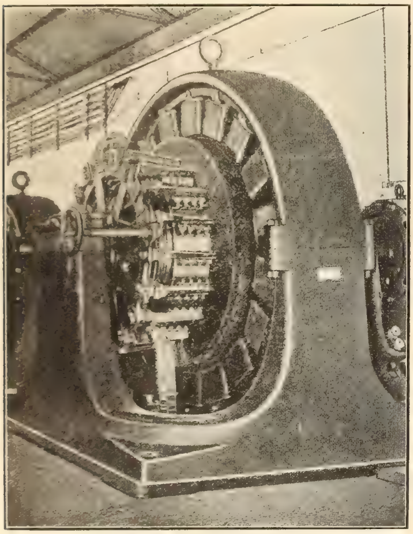
*From the Electric Club Journal, Pittsburg.

The rotary converters, on account of the type, naturally required considerable attention and some experimentation to get into satisfactory service. One of the characteristics of these machines, which occasioned special treatment, was the high commutator speed, which greatly increased the influence of surface roughness upon the commutator. The combination of high speed and roughness caused the brushes to vibrate, which resulted in rather poor contact between them and the commutator. Of course sparking took place. If the commutator was neglected, the sparking would accentuate the roughness of the commutator and this increased roughness would further aggravate the sparking, so that the sparking would increase at an accelerating rate until the machine would finally buck. This with a uniform load, while all other conditions were good. The cause was not fully understood at the time and it was thought to be chiefly in the setting of the brushes. After a short experince with this machine it was discovered that a smoothness sufficient for slow speed commutation might not be sufficient at a high surface velocity. Although the commutator might feel smooth to the finger, if the end of a lead pencil was pressed against the back of the brush, a good deal of vibration might be felt. In overcoming this it was found quite advantageous to support a piece of a grindstone on a properly constructed rest and crowd it against the commutator, while running with the starting motor. This was persisted in until a fresh surface was obtained. After following this up with very fine sand paper, a surface was gotten which caused no perceptible vibration of the brushes.


400 K. W. Rotary Converter.

A further aid to smooth running was obtained by saturating the brushes with cylinder oil. Two sets of brushes were fitted to each machine and while one set was in operation the other was immersed in oil. After receiving the above treatment, a machine would commutate perfectly for a very considerable period of time. After this a few hours' work would be required to put it in shape again.

When first put into commission these rotary converters pumped quite badly and no adjustments of their fields would materially improve them in this respect. After some correspondence with the manufacturing company instructions were sent out to me to bore out the fields for a larger air gap and bevel the pole corners. The boring out of the fields was somewhat of a puzzle at first as the machines were too large to be handled by any machine shop in that territory. After a time a boring bar was located that had been used to bore out the cylinder of a medium sized Corliss engine. This bar was mounted in the bearings of a rotary converter after having been reconstructed to bore a sufficiently large diameter. It was belted to the end of the shaft of the other rotary converter which was carrying the railroad load. This belt was necessarily small and ran at such a low speed that it would not transmit power enough to pull the cutting tool through more than a very fine cut, but by taking a large number of cuts the bore was increased to the required amount. While this was being done the manufacturing company sent out two sets of copper dampers to be tried on the pole pieces. One of these sets consisted of sheets of copper bent to the curvature of the pole face and each made to completely cover one pole face. The edges of each sheet was bent up an inch or so all the way around to secure it to the side of the pole piece.

As soon as the above changes had been made on one machine it was brought up to speed by the starting motor and the field was built up. Before, however, the field attained full strength, the machine commenced to make an ominous noise and slow down. On investigation it was found that the copper facings on the poles had bulged out against the armature and were actually acting as brakes on the armature core. The armature being of the open slot type, its teeth caused the magnetic flux in the air gap to gather in tufts, and as these tufts followed the teeth across the pole faces, they generated such excessive currents in the copper plates that the latter were discolored by heat and pulled out of position by the magnetic action of the induced currents. This difficulty was so great that these dampers could not be used at all. Their action is now well understood and with partially closed slots they make an effective damper. The other set of dampers was made of rectangular bars of copper surrounding the pole pieces near the tips. Their use and the change in air gap and beveling of the pole corners, resulted in decreasing the pumping to an unobjectionable amount.

Before the above difficulties had been overcome, and, in fact, immediately after the railroad had been transferred from the old steam plant to the rotary converters, the local telephone company and a considerable number of its patrons, whose lines were placed directly above the railway feeders, were much disturbed by a hum in the telephone receivers whenever they were raised from the hooks. In some cases this hum could be heard across a large room, and when the receiver was placed to the ear the noise was very disagreeable. A periodic variation of the sound in synchronism with the pumping of the rotary converters was its most noticeable feature. It did not take the telephone company long to locate the cause of the disturbance and they then proceeded to make things interesting for me, among other things hinting that steps would be taken to prevent the operation of the sub-station. This looked pretty serious, as the rotary converters were of a new type and anything tending to bring discredit on them would surely affect future business.

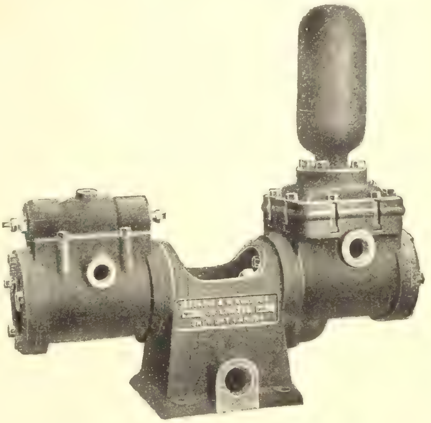
In situations like this it is of advantage to the roadman if in addition to being an engineer he is something of a diplomat. In this instance the roadman was not skilled in this direction, but he did his best to assure the telephone company that his company, to whom the matter had been reported, would do everything in its power to overcome the difficulty, and that a remedy would speedily be found, and then he lay awake at nights trying to think of a remedy, but without much success. Various theories had been advanced by different people to explain the difficulty. One was that the armature teeth, which were large and not very numerous per pole, presented varying amounts of iron to the pole faces, thereby causing slight fluctuations in the total magnetic flux, with corresponding pulsations in the e.m.f. and current. The vibration of the brushes was also thought to be a cause of the trouble, the vibration making the contact resistance a variable one with corresponding variations in the current. The smoothing of the commutator and the lubrication of the brushes described above would have reduced the effect of this cause and the increase in the air gap would have reduced any effect caused by the armature teeth. It was never determined how much, if any, of the trouble came from either of these causes, because the complaints from the telephone company suddenly stopped and no further investigation was made. The telephone company had found that the trouble existed mostly on circuits using a ground or common return and was negligible on an all-metallic circuit properly transposed. They evidently decided that the most satisfactory solution of the problem was the reconstruction of their circuits.

The transmission company had a few telephone troubles of its own. Its circuit from the power house to the sub-station was placed on the same poles as the transmission circuits and it consisted of two insulated wires under one covering. In addition to the braid common to the two, one wire had a braid covering and the other a rubber covering. I never learned just what reasons prevailed in the adoption of this style of construction. It was installed when I arrived and I was called on to operate it for a time. The main difficulty came in getting a sufficient amount of current through the circuit. The talk was very weak at all times. Another and very unique kind of trouble was caused as follows. In the country districts hunters were often out after small birds about the size of meadow larks. These birds frequently lit on the telephone circuit, and when the charge of bird-shot came, one or more of the shot would frequently wedge between the twisted telephone wires and short circuit them. As the wires were seldom cut in two and the insulation was but little frayed these faults were quite difficult for the patrolman to locate. These short circuits prevented the bells from ringing, but did not prevent the transmission of speech over the circuit, so the operatives at every recurrence of this trouble would simply go to the phones at pre-arranged times, lift off the receivers, and commence talking. This circuit was soon reconstructed with separated wires and this trouble ended too.

Some months later I was made superintendent of the power company and had ample opportunity to determine the expediency of various things I had done in getting the plant in operation.

STEAM BOILER FEED PUMP.

On this page we give an illustration of a steam boiler feed pump made by the Goldie & McCulloch Company, Limited, of Galt, Ont. The illustration gives a good general view of the proportions and construction, but the following description will be of interest to users of steam power. The base of the pump is cast hollow, forming a suction chamber to which the suction pipe may be attached on either side. The steam and water cylinders are both attached to this base and both overhang. This arrangement permits the cylinders to be removed for inspection or for repairs. The water cylinder lining, valves and seats, rod box, glands, nuts, etc., are brass. The piston rods are Tobin bronze or Muntz metal. These metals will neither tarnish nor corrode. All the regular lines of pumps have these in and do not cost extra. The pump cylinders are provided with a removable brass lining that can easily be taken out for reboring or exchange.



The pump is self contained, thus obviating the necessity for a large and expensive foundation. After the pumps are tested at the works they are properly packed and shipped ready to connect at once as soon as they arrive at their destination.

The prospectus of the Chilliwack Power & Light Company, of Chilliwack, B.C., furnishes some particulars regarding the proposed plans of that company. The president is Ald. Thomas Stout, and the secretary-treasurer Charles M. Oliver, both of Rossland. Mr. J. Burtt Morgan, of Chilliwack, is general manager. Messrs. Hermon & Burwell, of Vancouver, are the general engineers, with whom is associated Mr. Wynn Meredith, of Vancouver and San Francisco, as consulting engineers. The authorized capital is $500,000. It is proposed to harness certain waters power on the Chilliwack river for the generation of electrical energy for domestic and industrial purposes and for the operation of an electric railway between Chilliwack and New Westminster. A diversion of a portion of that river will be made at a point about seven miles above the Vedder Crossing and the water conveyed by a flume around the foot of the mountain for a distance of about 1½ miles. This will give a head of about 100 feet. At this point a power-house will be constructed in which two units of 1,000 h.p. each will be installed. The approximate cost of the dam, flume, power plant and transmission lines for the distribution of power throughout the municipality will be in the neighborhood of $125,000. Twenty-five year franchises have been obtained from the municipality of Chilliwack for lighting, power, telegraph and telephone purposes, and for the laying of tracks for tram-lines. The electric railway between Chilliwack and New Westminster will be about 60 miles long, and the engineers estimate that it can be built and equipped for $750,000. Franchises from all the municipalities through which the railway is to pass have not yet been obtained and the work of construction will not be commenced until next spring.

ENGINEERING and MECHANICS

BOILER INSPECTION IN BRITISH COLUMBIA.

The system of inspecting steam boilers which is in vogue in British Columbia has been found to be quite effective, and a steady decrease in the number of accidents is announced. Mr. John Peck, Chief Inspector of Boilers, gives in his last report the following particulars of the work :

I am pleased to be able to report that the work in all the districts has again run very smoothly ; in fact, there is little reason why it should not, as almost all the plants are now in good order, and any work that had to be done to meet the requirements of the Act, in most cases had been done previously ; with the exception, of course, of those plants on which first inspections were made this year.

Last year I reported that we had made 860 complete inspections, leaving 839 boilers on which no inspection had been made. This year we have made 890 complete inspections ; 364 boilers have been inspected for the first time, 199 of these being new boilers. During the year 14 boilers have been taken out of service, leaving 1,489 boilers on our report books. In addition to these, we have located 334 boilers that have not yet been inspected at any time, making a total of 1,823 boilers, leaving at the end of December 933 boilers on which no inspection was made, showing that the present staff are only able to do about one-half the work of the Province.

With respect to the summary of total work done, I may say that the testing of the boiler plates has resulted in nearly 10% of these being rejected, which is about the same as last year's figures. The new boilers installed are almost double the amount of the previous year, and the number built within the Province also doubled. The repairs list shows a decided improvement, being only about one-fifth of the previous year's account. The defects observed, together with those marked " dangerous," show a very material reduction.

Comparison and examination of the summary of total defects of the two years indicate that the engineers are more careful and are paying more attention to their plants, thus keeping them in better shape, so far as their part of the work is concerned.

SUMMARY OF TOTAL WORK DONE IN 1903.

No. of drawings and specifications calculated for new boilers	223
“ boiler plates inspected	87
“ boiler plates rejected	8
“ boilers built under inspection in British Columbia	107
“ boilers built under inspection in Eastern Canada	32
“ boilers built in Eastern Canada not under inspection	51
“ new boilers inspected built in the United States	26
“ new boilers inspected built in British Columbia	34
“ new boilers inspected (total)	199
“ boilers imported from Eastern Canada (second-hand)	4
“ boilers imported from United States (second-hand)	12
“ boilers unclassified	71
“ first inspections	264
“ inspections, external and internal	753
“ internal inspections only	3
“ external inspections only	27
“ special inspections after repairs	50
“ visits in addition to inspections	600
“ boilers subjected to hydrostatic test	812
“ boilers on which pressure was reduced	42
“ boilers unsafe without extensive repairs	8
“ boilers repaired under Inspector's directions	60
“ boilers considered unfit for further use	2
“ accidents to engines and boilers	20
“ accidents resulting in personal injury (not fatal)	4
“ investigations	5
“ inspections completed	890
Total horse-power of boilers inspected	42,223
Number of defects observed as per summary	1,514
Number of defects considered dangerous	89
Inspection fees earned	$7,729.39
Inspection fees collected	$7,407.61
Miles travelled by the Inspectors	25,764
Letters inward	3,682
Letters outward	6,424
Telegrams inward	79
Telegrams outward	73
Boilers taken out of service	14

SUMMARY OF DEFECTS OBSERVED.

Nature of Defects.	Number.	Dangerous.
Boilers with safety valves inoperative	2	2
“ with safety valves overloaded	3	2
“ with safety valves defective in construction	44	4
“ without pressure gauges	6	2
Pressure gauges inoperative	7	2
“ “ defective	121	3
Cases of insufficient staying or bracing	26	5
“ defective stays	31	1
“ broken rivets	65	0
“ defective riveting	16	0
“ broken stays or braces	6	0
“ loose stays or braces	65	5
Boilers damaged by low water	8	4
Defective settings	21	1
Boilers with fractured plates	12	3
“ laminated plates	4	2
“ burned plates	29	8
“ blistered plates	2	0
Cases of sediment on fire sheets	66	5
“ internal corrosion	30	0
“ scale or incrustation	107	7
“ internal grooving	18	0
“ external corrosion	45	1
“ defective tubes	45	3
“ defective feed water arrangement	75	0
“ broken feed valves	2	0
Serious leakage around tube ends	24	1
Serious leakage in rivet joints	54	0
Defective blow-off pipes or cocks	56	12
Defective water-gauges	26	1
Broken blow-off pipes or cocks	8	2
Water columns without blow-outs	21	2
Cases of broken test cocks	44	0
Connections to water columns without valves	72	1
Neutral sheets not stayed	40	0
Neutral sheets improperly stayed	6	0
Furnaces out of shape	0	0
Boilers without fusible plugs	102	0
Boilers low at front end	28	0
Cases of serious leakage of fittings	23	0
Number of hand-holes, doors having bolts and dogs burned off	16	0
Defects in engines	5	0
Boilers without hand-holes	7	0
Boilers without stop-valves	15	0
Cases of defective steam pipes	6	0
Unclassified defects	107	10
Total	1,514	89

OIL AS FUEL.

The Pacific Coast Steamship Company, which has lately been experimenting with crude petroleum as fuel for its steamers, has decided that oil cannot displace coal on its vessels. The experiments of the company were made on the steamer Coos Bay, on Puget Sound. Some time ago oil-burning apparatus was installed on the Coos Bay, and it was given a very fair test, with the result that the company has decided to revert to the use of coal.

The specific reasons for the decision against oil are not given by the company. It is, however, stated that in addition to the dislike of the engineering department for oil the passenger traffic officials have made complaint that many people refuse to travel by steamers burning oil as fuel, the travelling public being to a certain extent afraid to patronize vessels carrying oil tanks. While the popular belief that danger lies in the carrying of bulk oil may have been a factor in determining the decision of the Pacific Coast Steamship Company regarding oil, it could scarcely have been the principal cause of its rejection.

Mr. T. L. Roberts, fuel and locomotive inspector for the C.P.R. western lines, has gone to New York to continue a series of experiments which the company is making with the Canmore and Bankhead coal. The results of the experiments made to date have not been announced, but it is learned unofficially tha tthey have been most satisfactory and go to confirm the belief that the deposits of those districts are among the most valuable on the continent for steam purposes. Another valuable point is the ease with which the veins may be worked and accessibility of the mines from the railway.

SPARKS.

The Manitoba Water Power Electrical Company, of Winnipeg, have made application for permission to increase their capital stock.

The Pocock Power Company have submitted a proposition to supply electric light and power to Dominion City, Man., from a plant to be installed on the Roseau River.

Application will be made at the present session of the Manitoba Legislature for the incorporation of the Central Canada Railroad & Power Company, for the purpose of building an electric railway to the Winnipeg river and developing power on said river.

Messrs. M. P. Davis & Company are announced to have thrown up their contract on the wheel pit and tunnel of the Toronto and Niagara Power Company as a losing venture. Mr. A. C. Douglass will complete the work.

At the regular meeting of the Stationary Engineers' Association, held at Victoria, B.C., on December 15th, the fourth of a series of papers now being given by the members was read by Mr. F. C. Winterburn, his subject being "Injectors." The paper was illustrated by diagrams.

The Montreal Street Railway Company have arranged for the expenditure of $500,000 during this year in securing and distributing additional power and making improvements over the system. It is proposed to build three sub-stations at different terminals of the system, each to provide 1,000 horse power, thus enabling the company to put any number of cars on all parts of the system any time during the day. The sub-stations in the west and north ends of the city will be supplied by direct lines from the Shawinigan power station at Hochelaga. The third station will adjoin the large central station, which will then be used only for the lines in the centre of the city.

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TELEGRAPH and TELEPHONE

SHORT-CIRCUITS.

Mr. J. A. Follansbee, of Newcastle, N. B., is installing a new switchboard in the telephone exchange at Campbellton.

According to the plans now under consideration, the Bell Telephone Company will construct about 200 lines of new line in the Northwest this year.

The Bell Telephone Company are said to be considering the erection of a new building and the installation of the central energy system at Brantford, Ont.

Mr. A. W. Gibson, manager of the Bell Telephone Company at St. Johns, Que., has been appointed superintendent of the Sherbrooke district, with headquarters at Sherbrooke.

The Canadian Pacific Telegraphs have recently completed a new building for their accommodation on St. Peter street, Quebec. The offices are well appointed and fitted up with every modern convenience.

The New Brunswick Telephone Company contemplate erecting a brick building with brown stone front at Fredericton, N.B., during the coming summer. The central energy system may also be installed.

The Dominion Government had in operation at the close of 1903 6,241 miles of land telegraphs and sea cables, and it is estimated that the present mileage is 6,584, with 299 offices. The whole of these lines have been constructed by the Public Works Department.

The International Telephone Company, of Rainy River, Ont., have elected the following officers :—President, D. Robertson, Rainy River ; vice-president, E. J. Boucher, Stratton ; directors, Percy Roberts and J. A. Mathieu, Rainy River ; and H. J. F. Sissons, Fort Frances.

Mr. W. R. Griffith, who has been employed by the Bell Telephone Company in Winnipeg for eleven years, has been transferred to Calgary. Before leaving Winnipeg he was presented with a solid silver tea service, the address and presentation being made by Mr. Buckwell.

Mr. L. S. Humes, of St. Paul, Minn., has been appointed general superintendent of the Great Northwestern Telegraph Company, with headquarters at Toronto, and under the direction of the general manager, Mr. I. McMichael. Mr. Humes is a native of Illinois, having been born at Greysville on April 4th, 1859. He was associated with the Western Union Telegraph Company at Minneapolis when Mr. McMichael was general superintendent of the system.

The Independent Telephone Company of Canada have made application to the Manitoba Government for incorporation, the promoters being residents of Minneapolis and the State of Iowa. It is proposed to establish in Winnipeg and in towns throughout the Province the dial system of telephones. The capital stock is fixed at $10,000,000 and it is estimated that it will cost $2,000,000 to install a system in Winnipeg. Dr. McInnes, of Brandon, is fathering the bill in the Legislature.

The Richibucto-Rexton Telephone Company, Limited, has been incorporated, with head office at Richibucto, N. B. The capital stock is $20,000 and there are thirty-one names on the charter of incorporation. It is proposed to acquire the telephone system of the Kent Electric Company, Limited, in the county of Kent, N. B., and that of the Kent Telephone Lines Company, Limited, in the counties of Kent and Northumberland, also to construct systems in different parts of New Brunswick.

By a majority vote of 598, Edmonton, N. W. T., has declared in favor of raising $27,000 for the purchase of the Edmonton District Telephone System and the improvement of the service. The system extends to Strathcona, 25 miles to Fort Saskatchewan, 20 miles to Morinville, 40 miles to Leduc on the south, and to Stoney Plain Centre on the west. There are four exchanges, Edmonton, Strathcona, Fort Saskatchewan and Prince Albert, with 390 subscribers. To serve these there are strung 150 miles of wire, with eight switchboards having a capacity for 425 telephones. Besides this main system, there are operated by the company branch lines running to Leduc, St. Albert and other points.

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Edited and compiled by C. S. Vesey Brown, M. Inst. C. E., M. I. E. E.

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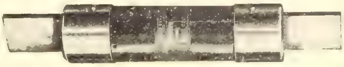

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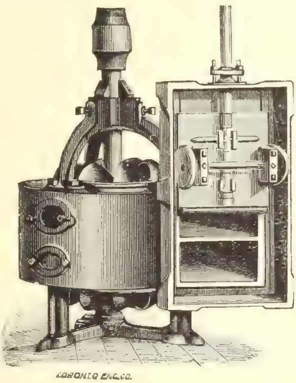
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SPARKS.

A public meeting will be held at St. Andrews, N. B., on January 10th, to consider the question of installing an electric light plant.

It is probable that the new council of Port Arthur, Ont., will consider the installation of another power plant on the Current River.

A combination of the electrical interests of Ottawa has been spoken of in the daily press, the supposed capital being given as $10,000,000.

The Canadian General Electric Company have been given the contract to install a turbine power plant for the Canada Car Company, of Montreal.

Mr. R. W. Farley, city engineer of Hull, Que., has been instructed by the City Council to prepare estimates of the cost of installing an electric plant.

The City Council of Fredericton, N. B., have not yet reached a decision regarding the installation of an electric plant for lighting the municipal buildings.

Incorporation has been granted to the Universal Spring Motor Company, Limited, of Toronto, with a capital of $250,000. It is proposed to manufacture electrical motors and other power appliances. The directors are Messrs. George H. Campbell, of Toronto; W. J. Johnson, of Springfield, Ohio; Simon Metcalfe, of Galt, and others.

The Jones & Moore Electric Company, of Toronto, are installing two 500-light dynamos, direct connected to Robb-Armstrong engines, in the departmental store of the W. A. Murray Company, Toronto. They have also installed a new generator for the Page-Hersey Iron & Tube Company, of Guelph, Ont.

At a recent meeting of the directors of the Otonabee Power Company, of Peterboro, Mr. R. R. Hall was elected vice-president in the place of W. A. Stratton, deceased. A dividend of 3½ per cent. for the last six months was declared on the preferred stock, making a dividend of 7 per cent. for the past year.

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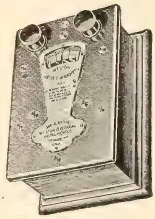

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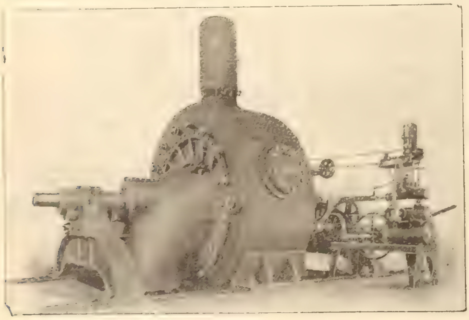

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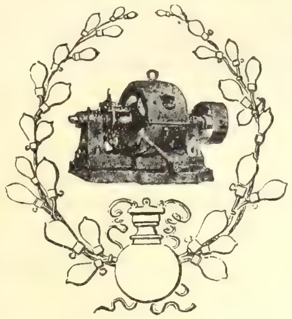

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It is stated that the contract for the construction of the Hamilton, Ancaster & Brantford Electric Railway has been let to Haines Bros., of New York, at an estimated cost of $500,000. The contractors take over the stock and bonds of the company. Mr. I. K. Pierson, of Cleveland, will, it is understood, be chief engineer and will have charge of the work of locating the road.

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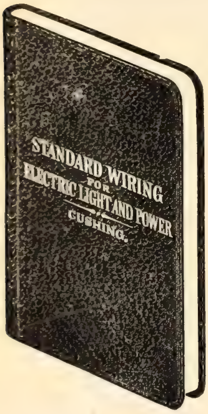

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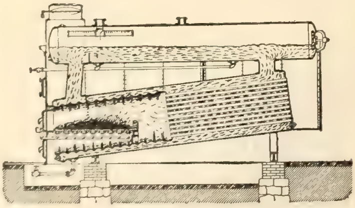

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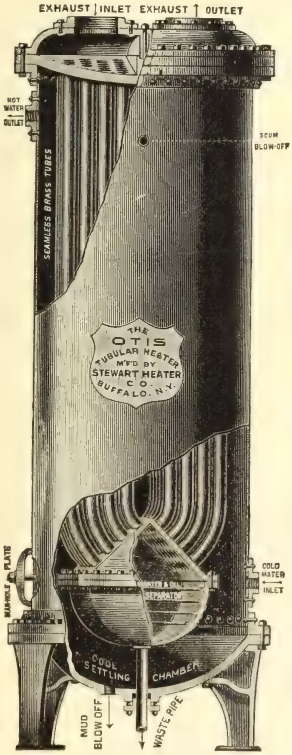

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SPARKS

The Canadian Westinghouse Company have recently installed a revolving field generator in the power house of the British Columbia Electric Railway Company at Victoria, B. C., thus doubling the capacity. The new machine is of 1,000 kilowatts.

The Wahnapitae Power Company, Limited, has been incorporated, with head office at Sudbury, Ont., and a capital of $250,000. It is proposed to develop and transmit electric power. The directors are Messrs. Frank Cochran and William McVittie, of Sudbury, and C. A. Masten, of Toronto.

The first annual general meeting of the Mexican Light & Power Company was held in Montreal on December 21. Mr. F. S. Pearson, vice-president and consulting engineer, submitted a report on the progress made in the work of construction, which stated that the first transmission line into the city of Mexico would be completed by April 1, and that the company had already made contracts that would assure them disposing of all their power. The second transmission line would be ready by June 1. Mr. C. H. Cahan, treasurer, reported that the earnings from the present lighting company of Mexico amounted to $380,000.

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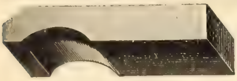

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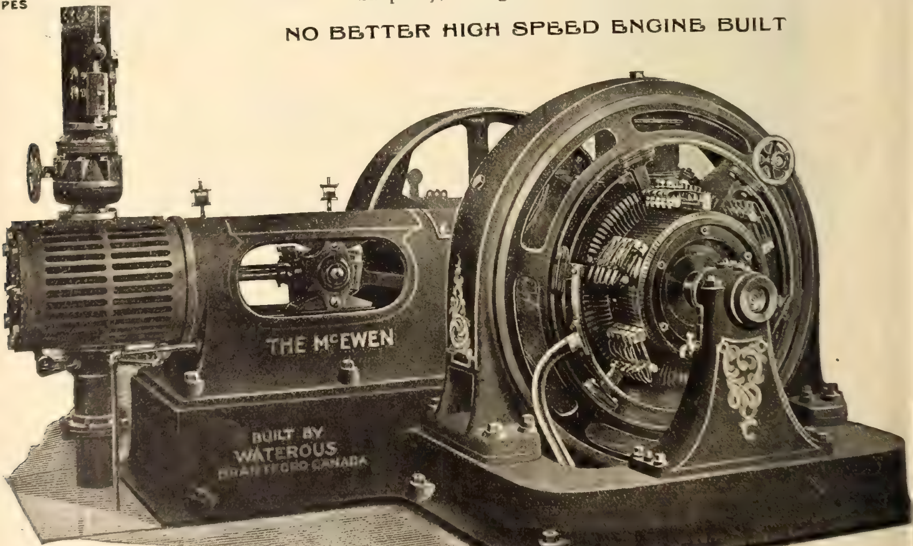
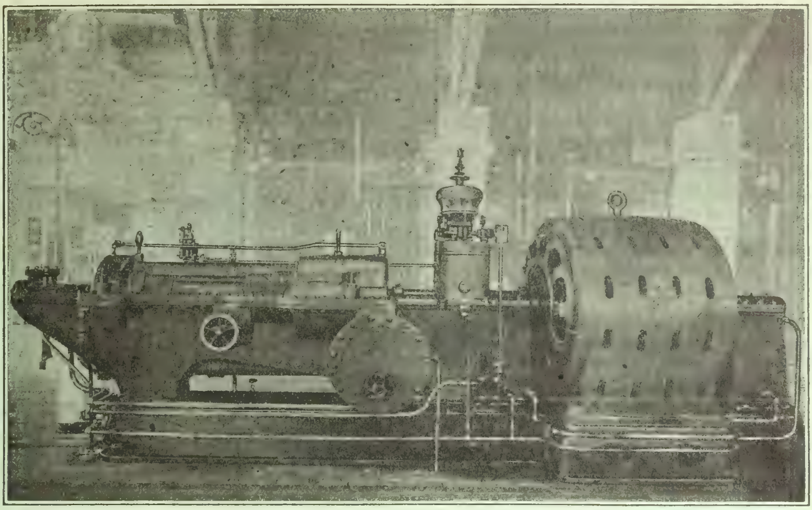


WATEROUS, BRANTFORD, CANADA



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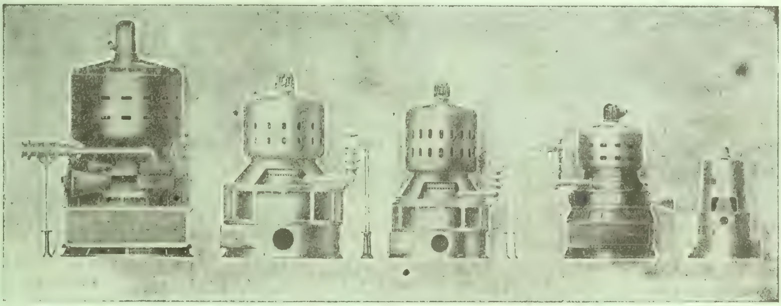

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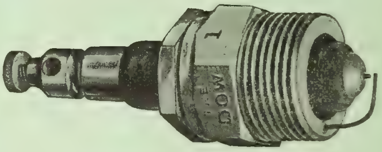

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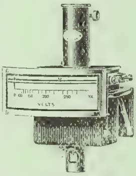

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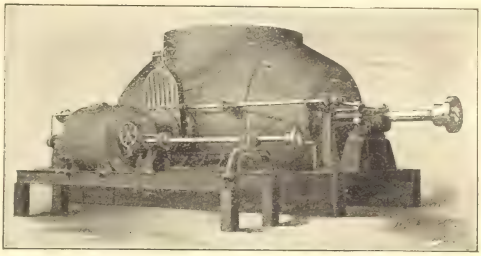

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The costs of the **Rhodes Motors** are lower than those of other manufacturers; the absolute simplicity of standardization assisting to that effect. The cost of equipping a factory for this purpose is very small, or existing factories with modern tools can be brought into use.

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We also supply particulars of generators of similar sizes and built in the same type of frames; also the data of the well-known **R F** Type Alternating Current Single Phase Motor, specially adapted for Lift Work, of the Commutator and Slip Ring Type, which starts up with double full load torque with only normal running current, a most efficient motor having a good power factor. This machine absolutely starts up on double full load without a kick of any description.

The services of an experienced engineer will be supplied to purchasers who will assist to carry into effect the necessary organization.

We shall be pleased to hear from anyone who is interested in such a proposition.

RHODES ELECTRICAL PARENT SYNDICATE, LIMITED

70 and 71 Bishopsgate Street, Within, LONDON, E. C.

THE TORONTO RAILWAY COMPANY.

In the report presented at the annual meeting of the Toronto Railway Company last month, it was shown that there had been a large increase in the operating expenses of the road, the percentage of expenses to earnings being 58.2. The report as compared with last year follows:

	1904.	1903.
Gross earnings	$2,444,534.24	$2,172,087.85
Operating expenses	1,424,179.54	1,200,823.39
Net earnings	1,020,354.70	971,264.46
Passengers carried		7,072,138
Transfers		1,825,926
Percentage of operating expenses	58.2	55.3

Increase.

Gross earnings	$272,446.39
Operating expenses	223,356.15
Net earnings	49,090.24
Passengers carried	1,826,923
Transfers	1,826,926
Percentage of operating expenses	2.91

The increase in net earnings is 12½ per cent. After payment of the city's percentage, $347,609, as compared with $298,839 the previous year, and fixed charges, the net income was $625,962, against $628,349 last year, an actual decrease of $2,387. The quarterly dividends, at the rate of 5 per cent., took $334,009, pavement charges $73,873, against $71,986 the previous year, leaving a surplus of $218,078, of which $200,000 was transferred to contingent account and $18,078 to profit and loss.

There was expended on capital account during the year $804,779.48, in addition to the power plant, rolling stock, etc. Large expenditures have been charged for renewals in steam plant and tracks.

To the wages agreement with the men, to be in force for the next three years, is to be attributed the increase in percentage of operating expenses. This percentage during the term of the franchise has been: 1893, 59.07; 1894, 54; 1895, 49.3; 1896, 50.9; 1897, 48.8; 1898, 47.4; 1899,, 48.8; 1900, 51; 1901, 51.6; 1902, 55.3; 1903, 55.3; 1904, 58.2.

The solicitors' department reported that the railway could at worst only be held liable for four of the twenty-four deaths caused by the cars during the year. Accident claims paid last year totalled $1,304.70, of which $503.50 was for accidents which happened in 1903.

ALLIS-CHALMERS-BULLOCK BANQUET.

The directors of Allis-Chalmers-Bullock, Limited, celebrated their semi-annual meeting with their representatives from all parts of the country by tendering them and the office staff a dinner on January 17th at the Canada Club, Montreal. In the centre of the table was a large model in flowers of the crest of the company, a shield bearing the initials " A.C.B.," banked with maple leaves and bound with smilax.

The chair was occupied by Mr. George Bullock, of Cincinnati, who is president of the company, and the vice-chair by Mr. Henry MacDougall, of Montreal, the vice-president. There were over fifty persons present, all being directly interested in the company and including Messrs. B. H. Warren, president; W. Chalmers, treasurer, and W. H. Whiteside, general manager of sales of the Allis-Chalmers Company of New York, Chicago and Milwaukee; J. S. Neave, vice-president of the Bullock Electric Manufacturing Company, Cincinnati; R. W. Chaplin, second vice-president and general manager; Colonel Henshaw, H. J. Fuller, J. W. Pyke, Alex. Pringle, Phelps Johnson, W. C. McIntyre, directors.

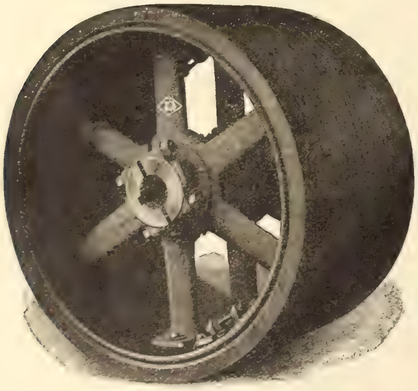
After the toast to the King, the president referred in hopeful terms to the outlook for the company. He looked to their salesmen for success and had every reason to believe that they would succeed. They would also receive the support of the parent companies, the Allis-Chalmers Company, the Bullock Company, the Ingersoll-Sergeant Company and the Lidgerwood Company. He proposed the toast of " The Salesmen," to which Mr. Alfred Collyer briefly replied.

Mr. B. H. Warren dwelt upon the relation of the salesmen to the company and of the value of co-operation in every walk of life. He maintained that good organization meant absolute success.

Other brief speeches and a programme of music and song made up a most enjoyable evening.

A proclamation has been issued by the Dominian Government bringing into effect the charter passed last session incorporating the Brantford and Hamilton Electric Railway Company, with power to construct an electric railway from Brantford to Hamilton. The company must expend $45,000 within two years and complete the road within five years.

The Perfect Pulley for High Speeds



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The Rim is Bolted to
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So that it cannot get away !

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SPARKS.

The Quebec Legislature will be asked to incorporate the Longueuil Tramway Company, to build an electric railway from Montreal to Longueuil. The applicants for incorporation include Hon. Jean Girouard and Mr. Joseph Riendeau, Inspector of Fisheries.

The Stark Telephone, Light and Power Company have made a proposition to take over the electric plant at Weston, Ont., at a valuation of $8,000 and furnish 20 arc lights for the streets at $60 per light per annum until midnight, or $72 per light for an all night service, the Stark Company's plant to be exempt from taxation for ten years.

The Dailey Rotary Engine Company, of Galt, Ont., has been incorporated by the Ontario Legislature, with a capital of $100,000. The purpose of this company is to build a rotary engine from patents held by Mr. C. Hetherington. The officers are: President, R. Erickson Brown; vice-president, Charles Turnbull; secretary, Andrew Oliver; treasurer, C. Hetherington.

The electric road from Windsor to Chatham, Ont., is believed to be assured. The company will be known as the Windsor, Essex and Lake Shore Rapid Railway Company and their American headquarters will be at 1020-23 Chamber of Commerce, Detroit. Mr. William L. Wilson, Supreme Secretary of the Home Protectors' Loan Company, Port Huron, Mich., is said to be one of the promoters.

The franchise of the Montreal Street Railway has yet eighteen years to run. The company have made a proposition that if the privilege is extended to fifty years, they will pay to the city as a cash bonus the following sums: $100,000 per year for eighteen years; $150,000 per year for following ten years; $200,000 for following ten years; $250,000 for following twelve years. It is estimated that, with the revenue due in percentages, the city would receive from the Street Railway Company during the fifty years a total of about $22,000,000. The company ask an exclusive right to use the streets for the operation of cars; the privilege of hauling freight over lines, and the right to regulate the speed of cars, but not to exceed fifteen miles an hour. If the snow is removed by the company, the cash bonus is to be reduced by one half.

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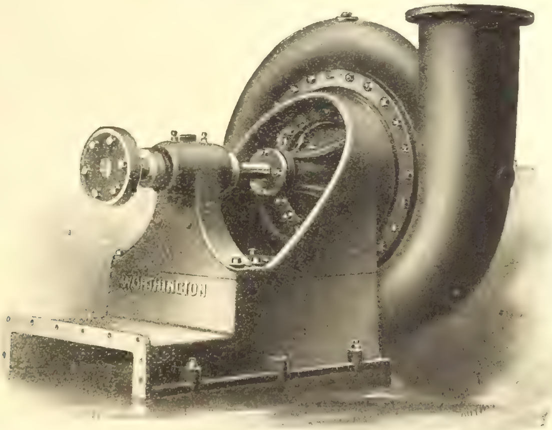

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Eighteen Inch WORTHINGTON VOLUTE PUMP
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Capacity, 10,000 gallons per minute against 25 feet head.
Worthington Turbine Pumps are Reliable, Durable, Efficient and Exceedingly Simple
The John McDougall Caledonian Iron Works Co., Limited, Montreal, Que.
BUILDERS FOR CANADA

SPARKS

Ratz Bros. have just added a new dynamo of 1,500 lights capacity to their electric plant at Elmira, Ont.

The Town Council of Goderich, Ont., are now considering necessary improvements to the electric light plant. The engineer states that an expenditure of about $10,000 is required.

The Petewawa Power Company have submitted to the Town Council of Pembroke, Ont., the terms upon which they desire a franchise to distribute light and power within the municipality.

Mr. Willis Chipman, C.E., of Toronto, has been commissioned by the Town Council of St. Mary's, Ont., to furnish an estimate of the cost of making improvements and additions to the electric light plant.

The proprietor of the Fraser House at Port Stanley, Ont., is said to have decided to install an electric plant for lighting the hotel and grounds and to build an incline railway to be operated by electricity.

The Sydney and Glace Bay Railway Company, of Sydney, N. S., have installed a new boiler in their power house. It is of the improved Mumford type, manufactured by the Robb Engineering Company, Amherst, N. S.

The Canada-Middlesex Railway Company, now applying for a Dominion charter, propose to build an electric railway from St. Catharines to London, Ont. Work will be commenced on the road, it is stated, as soon as the necessary legislation can be secured.

The electric light plant owned and operated by the city of Victoria, B.C., is taxed to its full capacity, and the Council may take some steps this year towards extensions and improvements. The present open arc lamps are likely to be replaced by modern enclosed arcs, and a reserve plant has also been spoken of. Mr. M. Hutchison is the city electrician.

A syndicate of capitalists, headed by Mr. Frederic Nicholls, of Toronto, have purchased the Niagara, St. Catharines and Toronto Electric Railway. It is understood that there will be no change in the management, but a new board of directors has been elected to represent the new owners, Mr. Nicholls being president and Mr. E. R. Wood vice-president. The other directors are Messrs. Z. A. Lash, Aemilius Jarvis, D. D. Mann and H. G. Nicholls.

The town of Owen Sound, Ont., now possesses a modern electric light plant, including two revolving field three-phase Swedish generators installed by Reid & Kilmer, of Toronto, one having a capacity of 75 k.w. and the other 150 k.w. These replaced two Royal and one Brush arc dynamos and one S.K.C. alternator. The old street lamps have been replaced by Westinghouse enclosed arc lamps of 2,000 candle power. Motors, arc lamps and incandescent lamps are run off one machine and good satisfaction is being given.

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$5.00 PER SET
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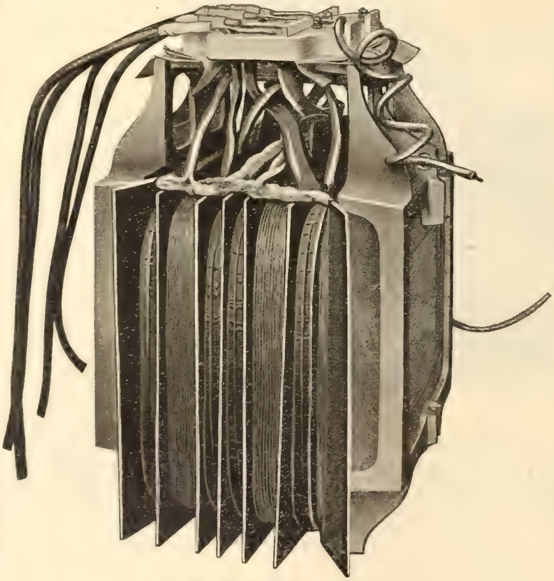

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High Efficiency
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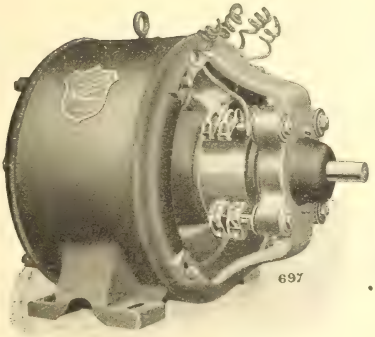

Open Motor Without Sub-Base or Pulley.

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DIRECT-CURRENT MULTI-POLAR

Especially designed and constructed for Direct Connection to Machine Tools and other Similar Service — A Prominent Feature in a Modern Shop.

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Push Button Switches,
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Standard Dial Surface Switches,
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Automatic Door Switches

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THE PACKARD ELECTRIC CO. LIMITED

ST. CATHARINES

MONTREAL - - - WINNIPEG

SPARKS

There is some talk of installing an electric plant for lighting and power purposes at Granby, Que.

The MacLaren Electric Light Company, Buckingham, Que., are adding a new dynamo to their plant for the purpose of lighting Masson as well as Buckingham.

Messrs. William Kennedy, hydraulic engineer, and R. S. Kelsch, electrical engineer, of Montreal, have recently been at Fort William, Ont., in connection with the proposed development of the Kakabeka Falls water power.

The Sarnia Street Railway Company, Limited, Sarnia, Ont., held their annual meeting on January 25. The following officers for the current year have been elected: President, J. D. Beatty; vice-president, James Flintoft; manager and secretary-treasurer, H. W. Mills.

The Winnipeg Electric Street Railway Company have elected the following directors for 1905: President, William Mackenzie; vice-president, William Whyte; secretary-treasurer, F. Morton Morse; Sir William Van Horne, D. D. Mann, A. M. Nanton and D. B. Hanna.

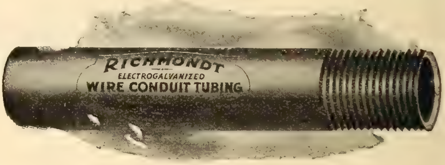
The contract held by the Toronto Electric Light Company for lighting the streets of Toronto expires at the end of the present year, and Ald. Harrison has suggested the appointment of a committee to take up the question of installing a civic plant for lighting the streets and municipal buildings.

The Maine and New Brunswick Electric Power Company will, in the early spring, commence developing their property at Aroostook Falls, N.B. There is a head of 75 feet and the company's engineer estimates that 4,000 horse power is available. It is said to be the intention to install five pair of wheels of 800 horse power each. It is proposed to furnish light and power to the principal towns in Aroostook County, Maine, and to Perth and Andover, in New Brunswick. The head office of the company is at Andover.

The members of the Canadian Society of Civil Engineers to the number of 150 visited the new works of Allis-Chalmers-Bullock, Limited, Montreal, on January 25th. They expressed surprise at the progress of the company, and at the amount and character of electrical work under construction. They were given an interesting demonstration on the construction and operation of drills, coal cutters and compressors. On leaving each member was presented with a handsome leather card-case as a souvenir of the visit.

The British Columbia Electric Railway Company are counting upon building this year twenty-one new cars for their different systems. Of these, fifteen will be for the service in Vancouver, two for New Westminster, and the remaining four will constitute the rolling stock of the new branch line to Lulu Island and Steveston. Of the Vancouver cars, eight will be passenger of the convertible type and will be constructed almost wholly of steel. Each car will have a seating capacity of eighty persons. A powerful baggage van will be constructed, also six smaller dump cars. For New Westminster there will be built a large interurban car 50 feet in length and carrying four motors. The cars for the Lulu Island Railway will be similar to those now running between New Westminster and Vancouver.

The RICHMONDT CONDUIT & MFG. CO., Limited
Sole Manufacturers of
Richmondt Electro-Galvanized and Navalite Conduit Tubing and Fittings
For Absolute Safety in Interior Wiring.



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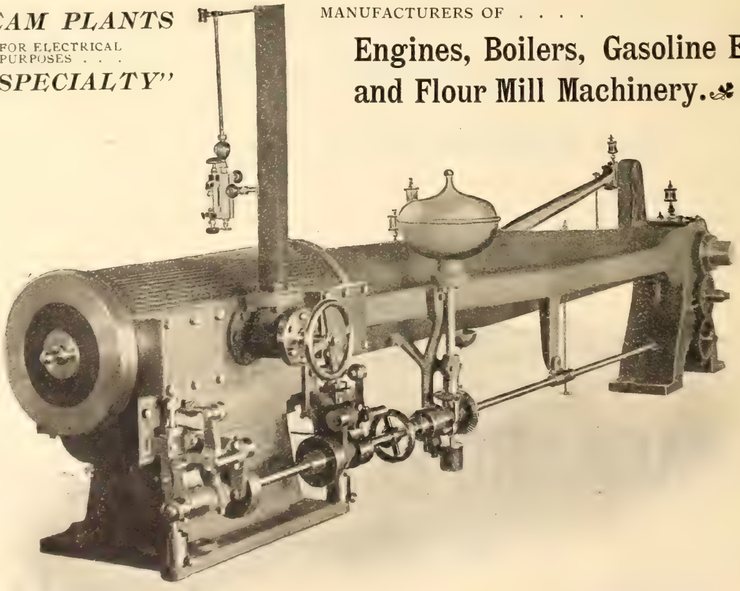
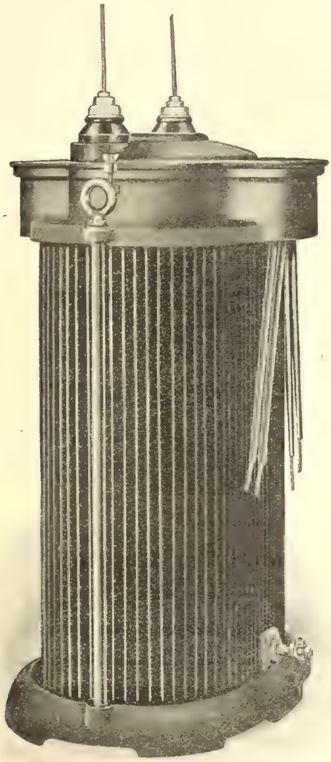
FOR ELECTRICAL PURPOSES . . .
"A SPECIALTY"

MANUFACTURERS OF . . . .
Engines, Boilers, Gasoline Engines and Flour Mill Machinery. ☘ ☘ ☘ ☘



THE BROWN AUTOMATIC ENGINE.



High Voltage Transformers

This is a 75 K. W., 11,000 and 1100-2200 volts, 60 cycles, oil insulated, self cooling Pittsburgh Transformer, and illustrates one of our smaller sizes for power transmission. These transformers show an unusually high efficiency and low temperature rise and are very substantially made. In this design especial attention has been given to circulation of oil and to insulation.

If you expect to install a transmission or to make extensions, write for prices and information on these transformers.

Pittsburgh Transformer Company
Pittsburgh, Pa.

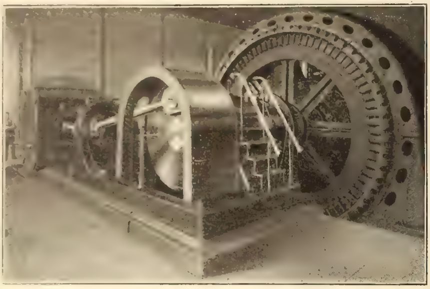
The Canada Car Company, Limited, of Montreal, have recently placed an order with the Canadian General Electric Company for two 500 k.w. alternators, 600 volts, to be driven by Curtis steam turbines, also for a steam turbine driven 25 k.w. exciter and an induction motor-driven 30 k.w exciter, together with 500 h.p. capacity of motors. This is the first industrial plant in Canada to adopt steam turbines and it will probably be the forerunner of many other similar installations.

The Metal and Jewelry Section of the Canadian Manufacturers' Association, Toronto, held a luncheon at McConkey's on February 8th, at which Mr. K. L. Aitken, consulting engineer, was the speaker. Mr. Aitken took for his subject "The Comparative Advantages and Cost of Steam and Electric Power" and the address proved to be of great interest. The relative cost of buying and making power was first dealt with, after which the question of mechanical versus electrical drive was taken up. About fifty members were present, and at the adjournment a very hearty vote of thanks was tendered to Mr. Aitken for his remarks.

"Canadian Machinery and Manufacturing News" is the title of a new monthly journal which made its appearance last month. The initial number consists of 68 pages, about two-thirds of which is reading matter of interest to the machinery trade. It has been accorded a liberal advertising patronage and starts out with bright prospects. The publishers are the MacLean Publishing Company of Toronto, the well-known proprietors of "Hardware and Metal" and other trade journals.

The Following Letter Will Give Some Idea of the Satisfaction These Engines are Giving.

We Offer no Comment Further :



Crank End View of one of the Engines in the Cataract Power Co's. Plant, Hamilton.

HAMILTON, CANADA, OCTOBER 26TH, 1904.

THE GOLDIE & MCCULLOCH CO., LIMITED
GALT, ONTARIO.

GENTLEMEN,—

Regarding the two Cross Compound Engines, size 28 and 52 x 46, installed by you in the Victoria Avenue Sub-Station of this Company, I would say that they have been running almost daily since the day they were put in about a year ago, and that they have given entire satisfaction. We are now running them every day with no heating, pounding or knocking. We are running 66 Cycle Westinghouse Alternators in parallel at 1 0 revolutions and I might say that these machines paralleled the first time they were thrown on the line together, and have since been all that could be desired in this respect, running under very close regulation.

The engines were rated at 1,500 horse power but we frequently carry as much as 2,000 H P. on each engine, which speaks for itself, the engines being non-condensing.

If any one, having in view the purchasing of an engine for this class of work, should call I would be pleased to show him the engines in operation. I remain,

Yours truly

WILLIAM A. SWEET,
Chief Engineer and Station Superintendent,
Cataract Power, Light and Traction Co., Hamilton, Ont., Can.

The Goldie & McCulloch Co., Limited, Galt, Ont., Canada.

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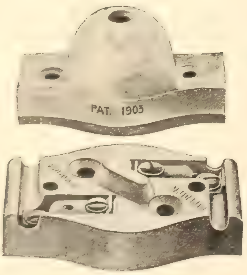
Fielding Cleat Rosette

Pat. August 25th, 1903.



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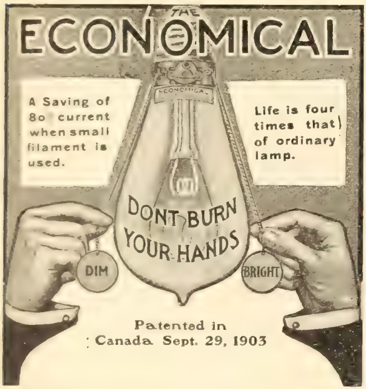
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Vol. XV. FEBRUARY, 1905 No. 2.

POWER DEVELOPMENT AT FORT FRANCES.

The announcement has been made during the past month that the Backus syndicate, of Minneapolis, have awarded the contract for building the dam in connection with the proposed power development on the Rainy river at Fort Frances, Ont., for which they have been given a franchise by the Ontario Government. The contractors for the dam are Messrs. Penniman & McGuire, of Providence, Rhode Island, and it is understood that the work will be commenced not later than March 1st. The syndicate have been given the right to develop the full amount of power, which is estimated at 60,000 horse power. A view of the falls is shown on this page.

Alberton Falls, on the Rainy River to Fort Francis, Ont. To be Developed by the Backus Syndicate.

The International Union of Steam Engineers, in convention recently in Omaha, Nebraska, decided to hold their next annual convention in Toronto.

GAS ENGINES FOR RAILWAY WORK.

A producer gas plant furnishes power for an electric railway running from Pugliano, near Naples, to a point about 325 feet below the actual summit of Vesuvius. The Dowson process is employed, and there are two 100-horse-power gas engines each driving a direct-current dynamo giving 137 amperes at 550 volts, and a storage battery having a 260-ampere power capacity over 1 hour. The dynamos, which are driven at 700 revolutions per minute, can be raised in pressure to 770 volts, it is said, for charging the battery without increasing the number of revolutions. The gas engines, which operate normally at 160 revolutions per minute, have cylinders 20½ inches in diameter and 29.9 inches stroke. About 175 cubic feet of water are required per hour for the gas apparatus and for cooling the engine cylinders.

NIAGARA'S POWER—PAST, PRESENT, PROSPECTIVE.

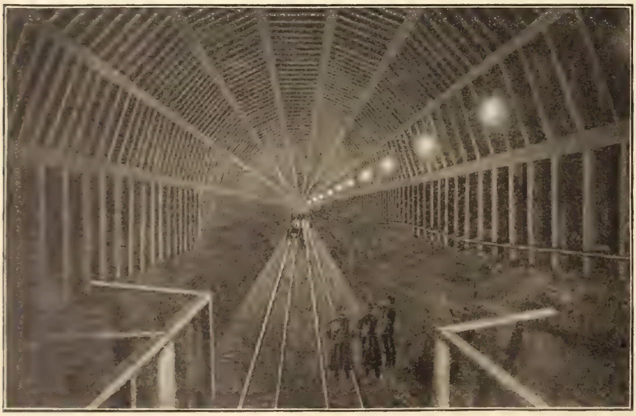
The many interesting features associated with the development of electrical power at Niagara Falls were reviewed at some length in a very able address given by Mr. Frederic Nicholls before the Empire Club at Toronto on January 10th last. As one of the promoters and general manager of the Electrical Development Company, Mr. Nicholls has acquired a very thorough knowledge of the vast engineering works that are under way for the harnessing of the Niagara power, and he was therefore able to present the situation in a most acceptable manner.

After briefly referring to the early geological history of the river and falls, Mr. Nicholls reviewed the efforts of the late Lord Dufferin and others which resulted in the establishment of the Queen Victoria Niagara Falls Park, and the steps subsequently taken to provide for the maintenance of the Park by awarding a franchise for the construction and operation of an electric railway between the Park and Queenston, the annual rental for which was $10,000. In the same year, the Commissioners gave to an English syndicate an option of the sole right of using for power purposes the waters of the Niagara river within the park, at an annual rental of $25,000. This option was renewed by the Commissioners from time to time, but Colonel Shaw, who held the option, being unable to interest the necessary English capital, associated with himself Mr. Wm. B. Rankine and others in the United States, and in 1892 the Canadian Niagara Power Company was organized. With the franchise of this company went the obligation to have completed water connections for the development of 25,000 h.p., and have actually ready for use 10,000 developed electrical horse power by the first of May, 1897. The company failed to develop the stipulated amount of power within the time allowed by their franchise and the Commissioners were therefore authorized to lease to others such additional power sites as were available after the final location by the Canadian Power Company of the limits of their concession.

Mr. Nicholls then outlined the agreements subsequently entered into with the Ontario Power Company and the Electrical Development Company of Ontario, and referred to the relation of the various undertakings to the present and prospective flow of the river in the following words:

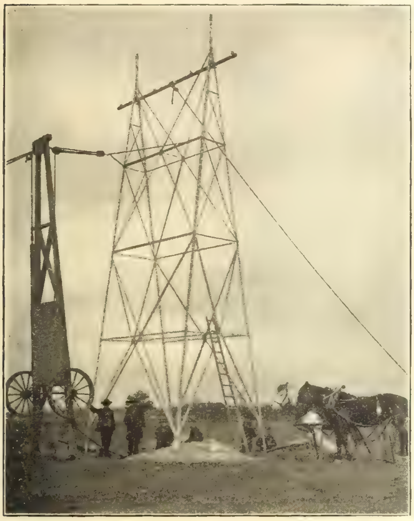
"I have previously mentioned that the total estimated horse power of the river passing over the Falls is from six to seven million, and a later authority, Mr. James Wilson, Park Superintendent, estimates that, after making liberal deductions, a total of 5,500,000 h.p. electrically can be safely assumed, 90 per cent. of which is at the Canadian or Horse Shoe Fall. When all the companies who are operating both on the Canadian and United States sides of the river have developed their concessions to their maximum output, which of course cannot be for some time to come, only about 78,000 cubic feet out of 223,000 cubic feet per second will be diverted, leaving 144,000 cubic feet plus 25,000 cubic feet (which is taken from the United States side), or a total of 169,000 cubic feet remaining on the Canadian side to perpetuate the scenic effects of the Horse Shoe cataract. Whether this deduction in years to come, of about 23 per cent. of the water passing over

Electrical Development Company—Excavation for Wheel Pit.



Electrical Development Company—Main Tail Race Tunnel, Showing Excavation Completed Ready for Lining of Concrete and Brick.

the brink of the Falls will detract from their granduer can only be estimated, but as a mere spectacle I am inclined to think that a depth of water of say from 12 to 14 feet projecting into the abyss below will be as awe-inspiring as ever."



Electrical Development Company—One of the Transmission Towers, Showing Derrick Used in Erection.

The special features of each development were then described by Mr. Nicholls. Referring to the work which has been done on the plant of the Electrical Development Company, he said in part:

"Our development radically differs in many ways from any of the others on either side of the river. A novel feature is that all the works of the company are practically constructed on what was previously the river bed—that is to say, that no encroachment has been made on park territory, but the room required has been wrested from the most turbulent part of the upper rapids at Tempest Point. To accomplish this it was a necessary preliminary to construction to unwater about twelve acres of the river, and the doing of this called for much engineering skill. The contractor having failed, however, to make the dam watertight, our engineering staff subsequently executed an inner dam which secured the desired result.

Electrical Development Company—Sub-Station as Used at Each End of High Potential Line.

With the forebay unwatered, work was begun on the headworks. A concrete gathering dam, with granite coping, extending up stream from the lower end of the wheel pit at an angle of thirty degrees, conducts the water to the gates, increasing the available head and stilling the water. This dam is designed to act as a spill-way for its entire length, thus enabling the surface ice to escape before reaching the submerged arches mentioned later. This action is still further increased by having the top of the last sixty feet—at the down stream end—three feet lower than the rest of the dam. The heavy ice will be that brought down from the upper lakes in the early spring. It is not expected to be large in amount, as most of it passes down the river near the centre of its flow. However, ample provision is being made to handle whatever amount may possibly come. The water before reaching the penstocks will have to pass through two rows of submerged masonry arches, separated by a quiet bay equipped with a spill-way at its lower end for passing off such ice as may be in it. Between the second row of arches and the gates lies a second bay equipped with a small spill-way at the end, and with a set of metal gratings in front of each gate. This last bay comes beneath the limits of the power house or generating station, and will consequently be covered.

"Nor was the work preliminary to the excavation of the main tail-race tunnel less devoid of excitement and risk, which at one time amounted to heroism. The main tunnel, which is the largest tunnel in the world, is about 2,000 feet in length by about 33 feet in diameter in the rough, that is to say, before it is lined with cement, concrete, and hard burned brick, which will reduce its area to 26 by 23½ feet. It is constructed 158 feet below the bed of the river, commencing at the end of the wheelpit, and discharging behind the falling waters of the Horse Shoe Fall about 700 feet from the shore. In order to reach this outlet a shaft was sunk at the brink of the Falls to a depth of 150 feet, and a construction tunnel 14 by 7 feet was driven to the point 700 feet distant, where excavation of the main tunnel would be commenced. When about half of the distance had been driven it was decided by Contractor Douglass to excavate an opening for the construction tunnel to the chamber between the face of the cliff and the falling water, for the purpose of dumping the debris into the river and save hoisting it up the shaft.

"The first hole was made near the ceiling of the drift, and immediately dense clouds of spray rushed in through the opening, and water, intercepted by the talus, began to rise in the floor of the tunnel. Powerful pumps were set to work to keep the water down, but the task was beyond them, and the water steadily rose until only a small space remained between it and the roof. If the rock at the mouth of the opening—which acted as a dam—could be removed, the water would immediately run out, but how to remove it was a puzzle. The emergency developed volunteers, and three were selected for a most dangerous service. A flat-bottomed boat was lowered down the shaft to the end of the flooded tunnel. It rode so high that it would not clear the roof, and ballast was put in to make it ride lower. The three men, with several boxes of dynamite and a lot of copper wire, then started on their voyage by lying down on their backs and propelling the boat by pushing with hands and feet against the ragged roof. When they reached the opening several hundred feet away, they placed the dynamite, connected the wires, and started on the return journey, the boat sinking under them just as they reached the shaft. The dynamite was exploded, but failed to entirely remove the obstruction, when another and equally daring method was tried.

Main Power House of the Winnipeg Electric Street Railway Company.

"Our chief construction engineer and two men, roped together like Alpine guides, started for the opening along the face of the cliff behind the Falls. At all times the spray was blinding in its intensity, and gusts of wind or compressed air would almost beat them to the ground, but they persevered until success crowned their efforts, and they stood in front of the opening, having ventured such a distance behind the Falls as had never previously been accomplished.

New Car Barns of the Winnipeg Electric Street Railway Company.

"Here the difficulty was diagnosed, and subsequent trips were taken to place a huge quantity of dynamite where it would do the most good, and on one Saturday near midnight the charge was electrically exploded. Supreme effort met its just reward. I am glad to say the obstruction was removed, and the water ran out of the tunnel, and ever since then there has been no set back of any kind, and the enormous tunnel, which has now been driven its entire length, is as dry and pleasant as this room.

"Apart from its being the largest tunnel ever constructed, there are several novel engineering features connected with it. Instead of commencing directly under the wheel-pit, it starts with two branches, one on either side of the wheel-pit. These join at a point 165 feet beyond the end of the wheel-pit, forming a section 26 feet high and 23½ feet wide, of a horse-shoe form, the object of the water wheels discharging alternately into a branch tunnel on either side instead of into one main tunnel beneath being to enable one half of the power house to be shut down at any time for examination of repairs, a feature unique with this installation. It is estimated that with the complete plant in operation the velocity of the discharged water will be 26 feet per second, and the quantity about 12,000 feet per second. Over the wheel-pit will be the generating station or power house.

"The power generated will be delivered by underground cables to the step-up terminal station of the Toronto & Niagara Power Company, which has been organized to distribute the output of the Electrical Development Company's power house. This terminal station is located on the top of the Niagara embankment above the park, about 1,500 feet from the power house. It will be about 200 feet long by 65 feet wide. The current will be delivered at about 12,000 volts, where it will be raised by the step-up transformers to 60,000 volts for transmission to a similar transformer station at Toronto, where it will be reduced by step-down transformers to the commercial voltage required."

WINNIPEG STREET RAILWAY IMPROVEMENTS.

The Winnipeg Electric Street Railway Company have been making important additions to their buildings and equipment. The illustration on this page of the main power house shows the new addition which was built last summer, the dimensions of which are 110 x 55 feet, with a strong truss roof. A 50-ton crane has been provided for handling the machinery. New boilers, engines and generators have been installed, and it is intended to further increase the plant in the near future. The architect for the new addition was Mr. J. Woodman. The Manitoba Construction Company executed the masonry work, while the iron and steel were supplied by the St. Paul Foundry Company, represented in Winnipeg by Mr. P. J. C. Cox.

The second illustration shows the new car barns which the company have built in the north end of the city, and which will remove the necessity of cars running through to the south end of the city every night. These buildings were erected by the company themselves.

THE CONCRETE-STEEL HEADWORKS OF THE ONTARIO POWER COMPANY, NIAGARA FALLS.

The adoption of concrete-steel construction for the headworks of the Ontario Power Company, of Niagara Falls, on the Canadian side of the Niagara River, is a conspicuous instance of the application of this material. The concrete-steel structures for controlling the flow of water to the pipe lines comprise an intake 600 ft. long, a screen house 320 ft. long, and the head block, the last being a mass of reinforced concrete for the entrance gates to the three pipe lines of the ultimate development.

The intake admits water from the river into a so-called outer forebay, from which in turn it passes through screens, housed in the screen house, where a traveling crane is to be provided for handling the screens, and from the screen house into the inner forebay which leads to the head block and thence to the pipe lines. The intake is designed to intercept water flowing along the bed of the river for a distance of some 440 feet from the shore line outward, and to divert surface currents toward the center of the stream so as to dispose of in that way the ice and debris floating in the intercepted current. The screen house is designed to catch sand and other heavy particles carried along the bottom of the outer forebay, in addition to screening such material as succeeds in reaching the outer forebay through the intake.

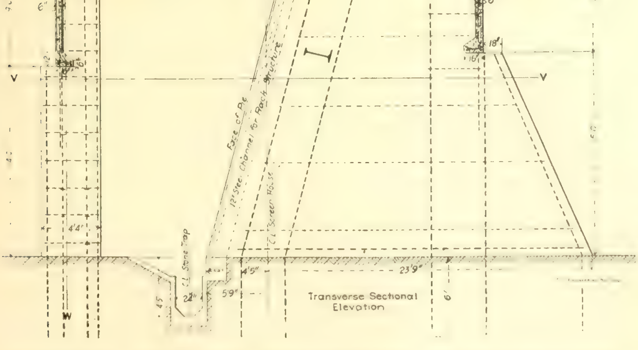
The intake structure, not yet built, is to have a total length of 600 ft., 596 of which lie across the waterway, the intake itself extending outward from the shore at an angle of about 135 degrees with the direction of river flow. It will consist essentially of a pier-supported submerged curtain wall stopped 6 ft. short of the bottom of the excavated approach to the intake, and leaving the wall submerged at low water about 5 ft. The supporting piers will be 4 ft. thick and spaced at distances of 24 ft., center to center, and the curtain wall will be continuous with a horizontal deck forming the operating floor for the intake gates. The piers themselves will be monolithic concrete, but will be continuous, so far as bonding is concerned, with the reinforced deck and curtain. Each opening through the piers will have a total span of 20 ft., and in order to avoid the use of a single gate for that width, a supplementary pier is to be built midway between the main piers to assist the curtain in carrying the thrust upon these gates when they are in their lowered position. This pier will be built independently of the rest of the structure and will be but 12 in. wide.

The screen house is about 320 ft. long and 31 ft. 8 in. wide at the water line. It is carried on columns along the inlet side and on piers along the outlet side, the piers providing for the steel racks or screens. The piers and columns are spaced 20 ft. apart on centers. The columns carry a curtain wall, serving, like that of the intake, for diverting debris and ice toward the river, and also longitudinal beams for the support of the screen-house superstructure. The piers similarly carry, in addition to the screen structure, five lines of longitudinal beams for the screen-house floor, the vertical steel-concrete columns of the superstructure and a curtain wall dipping below the water line on the outflow side of the screen house. The screen-house floor is 5 ft. above the assumed low-water level in the forebays, and the front curtain wall is deep enough to extend 4 ft. below low-water level and the rear curtain wall 3 ft.

CONCRETE STEEL FRAMEWORK OF THE SCREEN HOUSE, ONTARIO POWER COMPANY.

The main members of the substructure columns are 1-in. vertical rods tied together with ½-in. rods. The inner group of vertical rods of each column is continued a short distance above the screen house floor, where they are fastened to the upright rods of the reinforcement of the superstructure columns. Of the two beams carried by the substructure columns, one forms part of the curtain wall, and in this and other respects this curtain is quite different from that of the intake. It is but 10 in. thick, as compared with the 21 in. of the intake curtain, but is expanded at its lower edge into a beam, and is furnished with a reinforcement between the beam at the lower edge and that under the level of the screen house floor with a system of 5/16 in. vertical rods placed close to each face. The rear curtain is of the same construction.

The piers are 24 in. thick where they carry the heavier loads, that is, along the rear wall of the screen house, and are 18 in. thick where they are extended forward for the screen structure. The main members consist of 1-in. rods with ½-in. horizontal tie rods bent around them. While the space immediately over the screens will be left so that it can be



CROSS SECTION THROUGH SCREEN HOUSE SUBSTRUCTURE, ONTARIO POWER COMPANY.

reached from the screen-house, portable flooring will be laid over this part of the building, and for carrying it there are transverse beams extending from each pier to the corresponding substructure column. The sand trap is a longitudinal trench lined with concrete and provided with covers to be removed successively whenever sand is to be discharged from the foot of the screens through the conduit into which the sand trap leads.

The building walls are divided into panels 20 ft. long, corresponding to the spacing of the substructure piers, and the columns at each substructure column and at each pier carry a transverse beam and a longitudinal beam, by which beams the roof is supported. The longitudinal beams each carry the ends of two intermediate transverse beams, so that the transverse roof beams are spaced along the building at distances 6 ft. 8 in., center to center. The superstructure columns are 12 × 15 in. in cross-section, with four vertical 1¼-in. rods as the main reinforcement, and the longitudinal roof beams are 10 in. thick and 24 in. deep, while the transverse roof beams are 8 in. thick and about 22 in. deep. Those of the latter, which are carried directly by the superstructure columns, are slightly heavier than those intermediate, the group of rods in the heavier beams comprising two 1¼-in. and two 1-in. in size, while those of the intermediate beams consist of a pair of 1⅛-in. rods and a pair of 1-in. rods. The concrete portion of the roof is 4 in. thick, and, of course, in union with the concrete of the beams where it rests on them. It is reinforced with ¼-in. rods lying transversely midway between the upper and lower surfaces and by 5/16-in. rods running longitudinally, half above and half below the transverse rods.

The crane runway rails are carried by concrete-steel girders supported by concrete-steel brackets. The bracket extends 15 in. from the column to which it is tied, and is 12 in. wide. The way in which the steel members are tied together and fastened to the vertical rods of the column to which each is attached, is shown, and it may be stated that the laterals in the top are 1 in. in diameter. The crane girders are 10 in. wide and 20 in. deep, and similar in design to the roof beams.

The specifications called for a 1:3:5 concrete with 2-inch stone for the substructures, including the curtain walls, and ¾-inch stone for the superstructures. The reinforcement consists of medium steel of 70,000 lbs. tensile strength, and all the stresses were calculated on the basis of 16,000-lb. unit stress in the steel and 500 lb. per square inch in the concrete. The Lehigh brand of Portland cement was used.

The sand, obtained from a bank a short distance away, proved to be high in loam, averaging about 11.5 per cent. by volume, and its composition and the results obtained on tests with neat briquettes are of interest. The sand consisted of 6.9 per cent. which passed through a No. 1 sieve; 2.8 per cent. through a No. 2 sieve; 24.1 per cent. through a No. 5 sieve; 20.9 per cent. through a No. 10 sieve; 6.9 per cent. through a No. 20 sieve; 8.5 per cent. through a No. 30 sieve; 11.5 per cent. through a No. 50 sieve; and the balance through 100 and 200-mesh sieves, except, of course, the loam. Tests were made with 1:3 neat briquettes and the results compared with those obtained with 1:3 neat briquettes with the standard sand suggested by the American Society of Civil Engineers; that is, sand all passing through a No. 20 sieve. Such a standard briquette for seven days is credited with a strength of 205 lb. per square inch, while tests made with the sand employed in the work in question showed with 1:3 briquette a strength, at the end of seven days, of 462 lb. per square inch; with a 1:4 briquette for the same period, 343 lb., and with a 1:6 briquette, 205 lb., the last figure being exactly equivalent to the 1:3 standard briquette. A series of twenty-eight-day results were also obtained, comparing the figures with the 276 lb. credited to the standard briquette for this period; a 1:3 briquette gave 516 lb.; a 1:4 briquette, 429 lb.; and a 1:6 briquette, 281 lb.

Attention is called to the considerable area over which a relatively small amount of concrete was distributed. For example, in the entire screen house, both in the substructure and the framework of the superstructure, there are less than 1,100 cu. yd. distributed over a length of 322 ft., or less than 3½ cu. ft. per running foot. Similarly, for the 600 ft. of intake structure, the total amount of concrete will amount to about 3½ cu. yd. per running foot. The head block, owing both to its location and to the relatively large volumes of the concrete work, did not present the same conditions. The total amount of concrete comprised in the contract for the headwork structures described will amount to about 7,000 cu. yd. Owing to the fact, among other things, that the rock excavation necessary for the intake structure has not been entirely executed, work has not yet been started on this portion of the headworks, but the head block and the screen-house foundations and framework have been completed. This work was started about Sept. 10, and between that date and Nov. 15 the bulk of the work was entirely completed, and the contractor, the Reinforced Cement Construction Company, of New York, considers the expedition with which the work was peformed as noteworthy.

Four concrete mixers were employed, two for the head block and two for the screen house. The concrete plant for the head block was erected in the inner forebay and toward the inner wall, so that materials were readily discharged to it from the adjoining bank. Arrangements were made with the local street railway company for hauling the sand from the sand bank and cement from the railroad cars. Separate hoppers were provided for the crushed stone and the sand, and alongside of these a cement house was provided with a chute for sending the bags of cement from the top of the bank to the cement-house door. The mixer of this particular plant rested on the floor of the forebay below the level of the floor of the cement house, and the mixed concrete was dumped into a bucket which was lifted in place by a derrick of the stiff-leg type with a 90-ft. boom. For the screen house the contractor had to lay down a working track for the delivery of the materials and a self-propelling derrick was used, mounted on another set of rails parallel with the screen house, to lift the bucket to the point of use. Here concrete was mixed in quantities of 1 cu. yd. each, and was dumped from the bucket to be shoveled into the forms.

The difficulties of the work were due to two causes. There were few railroad facilities, and these were more or less congested on account of the large amount of work now in progress in the immediate vicinity on the Canadian side of the river. Labor was difficult to obtain also on this account, for not only was there a considerable demand for it in connection with the general power developments, but the town itself was engaged in a considerable amount of sewer work. The fact that the concrete for the screen-house structure had to be handled in small lots on account of the small sizes of the forms was also more or less of an obstacle to rapid erection. Altogether some 400,000 ft. of timber were required for the forms of the screen house and head block, and the quantity made it advisable to erect a wood-working mill, where a small harvesting steam engine unit and a circular saw were provided, enclosed in a light wooden house. Lumber planed on one side was, of course, purchased, but the power-driven saw was desirable both for cross-cutting and ripping. This house was erected in the forebay immediately below the bluff of the inner bank.

The reinforced concrete work described was designed and constructed by the Reinforced Cement Construction Company, under the supervision of the Niagara Construction Company, of which Messrs. L. L. & P. N. Nunn are engineers, and Mr. O. B. Suhr is resident engineer. The working force varied from 50 to 100, not including the engineers, foremen and carpenters. The enclosure of the superstructures was not included in this work, as concrete blocks are to be employed. Messrs. Green & Wicks, of Buffalo, are the architects for the buildings, which are designed with reference to their location within the confines of the Queen Victoria Niagara Falls Park. The intake structure is to be undertaken next spring, and by contract must be completed within sixty working days.—Abstract from the Engineering Record.

Depreciation of power plants should be charged off at the rate of 10 per cent. annually, according to Mr. R. F. Hayward, chief engineer of the Utah Light & Power Company. This should be figured on the whole cost of construction, whether the plant is operated by steam or water. "The neglect to do this may be hidden by reorganizations or abnormal growth of business," he states, "but it means financial failure sooner or later. It is extraordinary how often people who ought to know better will shut their eyes to this fundamental law of engineering finance."

For more than 20 years researches have been made with a view to fixing on a waterfall capable of furnishing sufficient power to supply St. Petersburg with electricity. Hitherto the most suitable for this purpose appeared to be a cataract in Finland, which it was proposed to utilize for the working of an electric tramway. Further researches, however, have resulted in the discovery of the Kiviniemi waterfall on the river Voksen (46 miles from St. Petersburg,) with energy equivalent to 25,000 horse power. Unless the difficulties of conveying the current rove insuperable, this waterfall will be purchased.

COMPARATIVE ADVANTAGES AND COST OF STEAM AND ELECTRIC POWER.*

By K. L. Aitken, Consulting Electrical Engineer.

When the title of the subject on which I am to speak was given me, I was somewhat perplexed as to whether I was to consider the comparative advantages and cost of putting a boiler and engine in a factory, as against the purchasing of electrical power from a central station, or whether I was to deal with mechanical versus electrical drive. Both questions are interesting, so I have decided to give consideration to each.

Whether power is to be made or bought, the heating of the building must be estimated. The cost of heating depends upon the purpose for which the building is to be used, the size of the building, its plan, the thickness and material of its walls, the number and size of windows and other openings, its exposure, and the external temperature. Having figured this cost, the power and lighting loads must be considered, and knowing the cost of current, it is a simple matter to ascertain the total cost per year for heating, lighting and power.

Installed in the building will be a certain number of motors and lights—therefore, for simplicity, I will consider the cost of generating electricity on the premises to supply this same equipment. The load curve must be carefully made up, and from this is derived the information necessary to decide on the maximum capacity of the plant, and as to how the units shall be divided. Then knowing the load variation, the cost of light and power per year can be figured, this cost including the labor and coal which would have been required for heating were no plant installed. I assume, of course, that the exhaust steam will be sufficient to take care of this heating.

In this way, the two schemes, reduced to a dollars and cents basis, may be considered. Two other important items enter into the proposition at this point ; first, if the machinery in the building require a very constant speed, better results will usually be obtained from a plant under your own control ; and second, if an accident occur in your own plant, it may mean a shutdown until repairs can be made, while in the case of buying current from a large central station, this risk is almost eliminated.

It is not possible to place before you figures in connection with actual costs—the expense of buying power depends on the supplying company, and the cost of producing depends on several variable quantities. Each proposition must be studied and figured separately—and practically no two ever work out alike. In many cases, an isolated plant, if properly laid out, will show a material saving, while, in the same case, the plant, if badly designed, will mean a serious and irrevocable loss.

To take up the two methods of drive—the mechanical and the electrical—I want to place before you, for illustration, the two extreme conditions, one of which can be found in the roll equipment of the Homestead Steel Works, and the other in the new C. P. R. shops at Montreal. In the former case, the big plate rolls are each supplied with its own boiler and engine—the amount of power required being extremely large, and the engine being attached directly to the roll. In the latter case, the total power used, while being on a large scale, does not compare with one of the single engines at Homestead, and instead of being used at one point, is distributed over a large area. At Homestead there are also some 30,000 horse power of motors used as are the C. P. R. motors at Montreal, and supplied from one power house.

Actual experience shows us that, with the exception of special cases, the capacity of the power house should be considerably smaller than the total of the motors connected. For instance, for the 30,000 horse-power of motors in Homestead, the power house has a capacity of but 4,000 horse power. The works cover such a large area that were mechanical drive used, and all the power delivered by the motors supplied from one point mechanically, the required capacity would perhaps reach 50,000.

In the case of a new factory, costing a total of, say, $500,000, and covering a fairly large area, we find that this total cost will install either mechanical or electrical drive. Although the power house capacity is smaller for the electrical, the first cost of boiler, engine, generator, switchboard, wiring and motors, will be somewhat higher than the first cost of a boiler and engine of the necessary size, together with belts and shafting. Still the saving in the size of all the buildings effected by the electrical equipment just about makes up this difference.

In the comparative operating costs, we find an interesting study. As the first costs are practically the same, the items of interest and insurance need not be considered. Depreciation will almost invariably show a saving in favor of the electrical drive, provided the item for shop attendance be kept the same as it would be for the mechanical. Incidental repairs, oil and waste, and other sundries, favor the electrical. In the power house proper is the greatest saving. The equipment being much smaller as I have already mentioned, the items of labor, coal, and water are correspondingly reduced.

When considering the efficiency of the two systems, the argument is often advanced that if the power of the engine be applied directly to the shop, then such a system must of necessity be more efficient than if the energy be transformed into electricity by a generator, with a loss ; transmitted by wires, with a loss ; and reconverted into mechanical motion by motors, with still another loss. This is a serious error, for it gives no consideration to the power which is continuously required to drive the belts and shafting. Numerous tests have shown that this will sometimes amount to fifty per cent. of the total energy delivered by the engine. Electrical apparatus has very high efficiency covering wide viariations of load ; for the purpose of making the point clear, figures in connection with the two methods of drive, applied under similar conditions, may be of interest. Consider that 100 horse-power is required by ten machines, and that with mechanical drive, 30 horse power is needed to turn the shafting. Then, when the machines are taking 100 horse power, the engine will be delivering 130 ; when using 50, the engine shows 80 ; when using 25, the engine gives 55, and when taking no power at all, the engine must still deliver 30 to run the shafting.

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*An address delivered before the Canadian Manufacturers' Association, Feb. 8, 1905.

With the electrical drive, the corresponding figures, given in the same order, are as follows :

H. P. delivered by motors.	H. P. delivered by engine.
100	131
50	67
25	40
0	13

Therefore, when delivering full power, the losses of the two systems are almost identical ; at half load the saving in favor of the electric drive is 16% ; at quarter load 27% ; and at no load 56%. Working on these figures and assuming that the average load is 20%, then the actual saving in power of the electrical system is 32%. With very few exceptions, the electrical drive means a lower coal consumption.

Now to come to the greatest consideration of all—the relative advantages. Manufacturers, in the past, and I may even say in the present, when about to locate a factory, have given great consideration to the cost of power, and in so doing have overlooked a number of other conditions of much greater importance. For instance, two towns are trying to induce a manufacturer to locate within their limits—one offers power at $15 per horsepower per year, and the other at $12. This will mean a saving of 20% in the power account in favor of one town, and looks worth while, when viewed from a distance. But suppose that the town which offers power at $15 is located on the main line of one of the railways, and that the other is out somewhere on one of the branches—then delays in goods in transit, either raw material coming in, or finished articles going out, may more than counterbalance the saving in the power bill. Therefore, at the best, to give primary consideration to the cost of power, is a very short-sighted policy.

Now, taking the business of manufacturing as a whole, the cost of power is, at the greatest, but a small percentage of the total cost of running the establishment—for example, let us consider it at 5%. If you can make a saving in your power account of 20%, it is certainly well worth while, provided it has no counteracting influence, but it reduces your cost of manufacture but one per cent. While the electrical and mechanical drives have the same initial cost, and the electric has lower operating cost, still there is one point in its favor upon which I have not touched, and that one point overshadows all the rest. With the electrical drive you get something which the mechanical system cannot possibly give you—a truly flexible control. If, without increasing either your power cost or your labor cost,in fact, increasing but the one item of raw material, you can raise your output of finished goods 20 or 25%, then surely the proposition merits consideration. To illustrate my meaning, take the case of an ordinary engine lathe. With the generally used speed changing system of cone pulleys and gears, the speed jumps are often as much as 100%. Consider three abstract speeds, 50, 100 and 200, each being an increase of 100% over the one just below. Take a certain piece of work, and consider that the best speed is 75. You cannot run that lathe at the 100 point and get satisfactory work, and consequently it must be run at 50. This means that the work in question will take just 50% more time to turn out than is really necessary. With the proper system of electrical drive, the lathe could run very close to the 75 point, and therefore at its maximum capacity.

Another point—against the mechanical drive—is that machinery has to be located in the shop with regard to shafting arrangements, while the governing condition should be convenience and rapidity in handling goods. When new machinery is to be added, it may mean material changes in the existing equipment—and such changes cost money and take time. With the electrical drive, extensions may be made without interfering with any part of the plant. Wwith mechanical drive you put your power house where you must; the electrical allows you to put it where most convenient.

Where shafting and big belts are running, the walls and ceilings are invariably dirty, and the shop is dark, to say nothing of the continual source of danger which the belts constitute. It is well known that the brightness and safety of an establishment are factors of the quality and quantity of the output.

Considering my remarks on the drive problem, they may appear rather one-sided, but if this be the case, it is because the proposition is one-sided. There are conditions which unquestionably call for the electric drive, and, on the other hand, conditions exist in many cases where such method of drive would be absurd. I have endeavored to touch on the governing features in a general way, and from an unbiased standpoint ; I sincerely trust that my opinions have been of interest to you.

I thank you, gentlemen, for your attention.

UNIPOLAR DYNAMOS.

By James Asher.

The first unipolar dynamo was used by Professor Michael Faraday, of London, in the year 1831. A few years previously Prof. Barlow had invented a small electric motor, which consisted in a toothed wheel whose teeth dipped into a drop of mercury between the legs of a permanent magnet. On passing a current along the shaft, then down the wheel and out through the mercury, a rotation of the wheel ensued. Sturgeon used a smooth instead of a toothed wheel and found that even then the machine worked as a motor. Now, in 1831 Prof. Faraday used a rubbing contact of wire instead of a mercury contact. Instead of sending a current into the little machine he placed a crank upon the shaft and turned it. A galvanometer in the electric circuit showed that when the user turned the machine in one direction,a current flowed say, toward the right, but when he turned the machine in the opposite direction the current flowed toward the left.

Apparatus designed for showing electric-magnetic rotations, on being mechanically rotated, generated weak currents of electricity. One of these consisted in a straight permanent magnet vertically mounted on pivots. On leading in a current at either one or both poles, and out at the middle of the magnet through a mercury trough, or vice versa, the magnet was set in rapid rotation. On disconnecting the battery and rotating the magnet mechanically, the galvanometer showed the presence of a current of electricity. When the direction of motion was reversed the direction of the current was likewise reversed. The machines so far described were not intended for industrial use.

Werner Siemens invented and constructed a unipolar dynamo which consisted in a horizontal U-shaped electro-magnet, round the poles of which two hollow cylindrical armatures of copper were caused to rotate. A second electro-magnet, having pole extensions, lay between the legs of this electro-magnet. The pole extensions nearly surrounded the copper armatures. These armatures were divided longitudinally into several sections, each of which was connected with a slip ring and several brushes, in order to increase the voltage.

Delafield invented a machine somewhat similar to that of Siemens. But in this machine the copper cylinders were not divided. The electro magnetic structure formed a consequent pole within each hollow cylindrical copper armature.

Professor Galileo Ferraris, of Turin, Italy, invented a unipolar dynamo. The electro-magnetic system consisted of two horizontal electro magnets laid end to end, and having their like poles in contact with each other. Within a semi-cylindrical cavity extending across the top of the upper consequent pole a plain armature rotates, while below a semi-cylindrical cavity extending across the lower consequent pole another plain cylindrical armature rotates. The lines of force, after passing through the upper armature, traverse its shaft and find their way into the shaft of the lower armature. They next pass through this armature and are led off.

Professor Crocker, of Columbia University, New York, in conjunction with Mr. Parmly, designed several unipolar dynamos about fifteen years ago. One of these consists in two large annular electro magnets standing in vertical plains ; the opposite poles of each field magnet are very close together. A hollow cylindrical armature carried on spokes, or on a spider, rotates with each end within the intense magnetic field. Brushes extend through holes in the magnet and carry off current from the armature.

Mr. C. E. L. Brown, of the firm of Brown, Boveri & Company, on the Continent, designed and constructed a machine somewhat similar to the foregoing.

Lord Kelvin (formerly Sir Wm. Thomson) constructed a unipolar dynamo consisting in a disk at two diametrically opposite points of which stood a vertical field magnet, within which rotated the disk armature. The disk was slit radially into many spokes. The current passed out at brushes pressing on either the broadened edge of the slit disk or on a hoop enclosing the same.

Polecho designed and constructed a machine similar to that of Lord Kelvin. The amperage was very great, but the voltage was low.

Professor George Forbes, of Glasgow, invented an iron-clad unipolar dynamo. A solid iron cylinder six by four inches in dimensions rotated within a thick, hollow iron cylinder, by which it was completely enclosed. Two magnet coils lay in grooves in the casing and opposite the ends of the armature. Brushes extended through holes in the casing near the coils. This machine gave an amperage of several thousand, but it yielded a voltage of only about two.

F. L. O. Wadsworth designed a massive unipolar dynamo having a vertical shaft. The two disk armatures are each divided into several sections connected with annular mercury troughs surrounding the machine. The disk is subdivided and the sections are connected with the troughs in order to raise the voltage. The shaft must be vertical in order to make use of mercury contacts entirely round the circumference of the disk armatures.

Mr. Heath, of the New England States, designed and constructed several forms of unipolar dynamos only a few years since. Perhaps his best design is that in which a massive yoke wound, vertical field magnet stands with hollow cylindrical poles uppermost and looking towards each other. These poles extended within a hollow cylindrical iron armature. This armature is electrically connected with the non-magnet shaft by a web. Brushes press against the armature near its ends. There are or may be several concentric cylinders, each fitting closely over but insulated from that within. Each cylinder may then have its own brushes. The voltage is higher when the machine is constructed in this manner. The current is led off from the shaft by ordinary brushes.

The unipolar dynamo yields an enormous current, but the pressure is very low. In other words, it gives great amperage but low voltage. The amperage per pound of weight of machine is far greater than that from any other machine. Lamination of armature or pole pieces is unnecessary; there is neither moving wire nor commutator. The machine is extremely simple, its first cost is low and it occupies little space. The current is perfectly steady. Did not Mr. Carl Hering write that when a telephone is in circuit with a unipolar dynamo you cannot hear the slightest sound ?

On the other hand, the voltage is very low, usually only from two to five, hence such machines are little used, except for electroplating. In order to secure even these low voltages, the machine must be driven at very high speeds. Difficulty is found in taking off currents of great amperage from the circumference of the rapidly rotating armature. Numerous brushes are requisite, they are liable to heating and wear, and the loss of mechanical power from torque of brush friction is considerable.

Many electrical engineers have tried to design unipolar dynamos which have neither brushes nor slip rings. But no man has yet constructed one which will work.

There appears to be no law of nature which asserts that the thing cannot be done. I think that it can be done ; moreover, I think that I shall soon have in operation a machine of this kind. I have given the subject some thought during the past twenty-two years. I had models made from time to time. All failed to work. I see now why they failed, and why other men's schemes failed. The common theory of dynamos is insufficient and unsatisfactory.

It does not appear that the unipolar dynamo has ever been practically used as a motor. This could easily be done, and it could best be done where either storage or primary batteries are available, for example in electric carriages. The cells of the storage battery might be connected so as to give a current of very low voltage but of great amperage.

I wish to call attention to a statement which is frequently made, to wit, that the term unipolar dynamo is a misnomer. Distinguished writers even condemn the use of the term unipolar as applied to a dynamo. They say, and say truly, that magnets have at least two poles. One writer on the other hand did not condemn the term unipolar. He says that the unipolarity refers to the current, not to the field magnet. A unipolar dynamo is one in no part of which is the direction of the current periodically reversed during the motion of the rotating portion of the machine.

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Municipal Ownership. The words "frenzied finance" can well be applied to the public ownership movement that has become so popular with some of our municipalities. They take up the consideration of the building of a power house, and right at the outset say, "We are going to sell power at $10." They don't know definitely what the plant is going to cost, and they have no idea whatever of the running expenses. The result of the whole thing is that when the plant is in operation, they find that $10 power is out of the question, and when an attempt is made to raise the price, the business drops off. There is a law in the State of Massachusetts which prohibits any municipality from selling gas or electricity below the real cost of manufacture, and if we had such a law in Canada it would be a very good thing. Then every Council, before building a new plant, or taking over a privately owned one, would make a most careful investigation of the cost of production, and the guesswork feature which how characterizes such deals would be eliminated.

Lamp Renewals. It is indeed surprising how little attention the average central station manager gives to the subject of controlling the incandescent lamps which are used on his circuits, and also how limited his knowledge is in regard to the advantages which arise from such control. Primarily, it is his business to supply electrical energy, and he seems to lose sight of the fact that his customers purchase this energy with the sole object of obtaining light therefrom. In our last issue, when speaking of the Montreal Light, Heat & Power Company, we said that it was the central station's chief desire to maintain friendly relations with the public. We might have gone somewhat further and explained that "friendly relations" usually result from a service which is satisfactory in every sense of the word. Very few consumers, where they have to buy their own renewals, will make such purchase until their lamps actually burn out—and then only with much grumbling. The direct result is that the consumer kicks when he has to go down into his pocket for money, and also kicks because his light is poor. On the first ground, he really has no complaint; on the second, he has, but its remedy is entirely within himself. He knows nothing of voltage, efficiency, and such like terms; candlepower, especially *sixteen* candlepower, is in his mind to a certain extent, but is regarded as a species of myth. Now, if a man contracts a bill with us to the extent of ten dollars, we find it more satisfactory to have him make payment in a lump, in preference to, say, a dollar a month plan. It may shock him to hand over ten dollars once, but it will shock him much more to have to hand over one dollar ten times. It is really the same in the end, but is far from appearing to him in that light. There you have the position of the consumer who buys his own renewals. Should he purchase a fairly good stock right at the outset, he would not feel so badly about replacing a burnt-out lamp; but when he buys them piecemeal, things appear to him somewhat differently. And besides—and this is the important point—he purchases the cheapest, longest-life lamp he can obtain, and much to his disadvantage. Therefore, it will be seen that when the lamps are out of the control of the central station manager, dissatisfaction is almost sure to exist. The disease cannot be cured, but its cause may be removed. To make the removal permanent and complete, the renewals should be given *free*. But how, and it is but a natural question, can any company afford to replace dim or burnt-out lamps with new ones, and make no charge therefor? They do not. But the consumer thinks they do, and can find no explanation, nor is he given any. Hence he is happy, he has good bright lamps and good light in consequence, and in his mind he cherishes the idea that the lighting company, though much abused, is really a philanthropist in disguise. Here is a condition which to our mind may be characterized by the term "friendly relations." But the consumer pays for his renewals just the same, though he may not know it. The lighting rate is made up to include the cost of "free" lamps, and when the little monthly, or quarterly bill, is received, you may truly say that a certain percentage of it is for new lamps furnished; only, as we said before, it does not appear in that guise. Let every central station manager give due consideration to this all-important subject, and the time he spends in studying the proposition will not be wasted. Mind you, furnishing new lamps at cost, or half cost, or at any charge whatsoever, will not accomplish the same results as if they are given free for the asking. And all lamps received back—make that a point, the old lamp, glass unbroken must be returned—are not useless; in many cases a little soap and water will make them as good as new. Experiment with your lamps; get the make best suited to your service, and buy in large quantities to get close prices. Do not get all the same voltage—there may be points in your town where the pressure is low, and therefore a lamp of lower voltage will give better results. There is one more point, and it is worthy of consideration. There are certain standard voltages used throughout Canada, and for illustration we will take 104 and 110. When a representative of a lamp house next comes your way, take him quietly aside, talk to him earnestly, and no doubt he will make you a nice low price on 102 and 108 volt goods, which he can ship in large quantities, and at once.

Light and Crime.

While our Canadian towns and cities are comparatively free from crime, still there is a point in connection with this subject which every municipality should bear in mind. Rowdyism, which constitutes crime in an incipient stage, is probably the most objectionable condition from the standpoint of the pedestrian, and wherever there is a specially dark street or corner, there you will find a rendezvous for all the young hoodlums in town. The remedy is simplicity itself. Make the street light, and the trouble will disappear, if not entirely, then to such an extent as to more than warrant the expenditure for the light. The next time your municipality is considering the wisdom of putting on an additional constable, get up at the council meeting and advocate that the money which they propose to spend on the police force be used for the installation of more arc lamps. Prepare convincing arguments to back your idea, and it will probably be adopted. There's a lot of good common sense in the scheme—the constable will not be on the dark streets continuously, but the lamps will do away with such streets. No less an authority than Police Commissioner McAdoo, of New York, has said in connection with this subject, "I have always believed that light would prevent a great deal of disorderly conduct at night in certain streets. I do not know of anything so effective as a means of ridding us of our many troubles. If they were to give me charge of the lighting of New York, as well as its protection, I would at least double the number of lamps now in use." Keep the thing in mind—a brightly illuminated town stands for a place characterized by progressiveness. If a business man goes to a certain place, with the object of locating a factory site, and has to stumble up from the station in the dark, the primary impression is not good, and as we all know, the initial impression is the hardest to eliminate. On the other hand, should he find the town literally flooded with light, it is certainly a material point in favor of that particular location.

Lifting Magnets.

The older we grow, the more we seem to learn, and the more we appreciate how little we really knew just a few years back. Phenomena, with which we have long been familiar, suddenly finds some new application, and we begin to realize that this same familiarity is not always a good thing—sometimes it breeds contempt. To those of us who manifested electrical inclinations in our early days, the magnet was probably the first step in our technical education. The magnet would attract and lift iron or steel, and the larger the magnet, the stronger this attraction, and the heavier was the metal which it would lift. This was certainly interesting, but as time passed, and the electro-magnet with its enormous power came into its many applications, we seemed to lose sight of the original experiment—that the magnet would *lift* iron and steel. The date of the commercial application of this property is not many years back, and to-day we find that the lifting power of the electro-magnet is of enormous value. In place of the cumbersome chains, which have heretofore been used in connection with crane work, a properly designed electro-magnet is suspended from the hook, lowered over the article to be carried, a switch closed, and all is ready for the lift. And instead of the time required with the old systems, it all can be done in as few seconds as it takes to tell it. Consider the saving in time, the saving in the wages of the crane gang, the safety, and the convenience of the thing. Before, when a heavy casting was set down, blocks were placed beneath it, so as to make possible the slinging of chains. Now that is not necessary. Plates, and like shapes, can be piled close together, thus effecting much economy in storage. And then there is the handling of hot castings, even red hot castings, which used to be the bane of the foundry chainman's existence. And the wonder of it all is that this use should be a recent, instead of an ancient application. But, no doubt, there are many things hidden from us yet. Twenty years ago it was said that all there was to be known in connection with electricity was then known, and ten years later the same remark was made. To-day we hear it occasionally, but those of us who know, know that we don't know, and the future holds many things in store for us.

The Western Manufacturing Company, of Indian Head, N. W. T., have installed an electric lighting plant in their works.

QUESTIONS AND ANSWERS

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1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

QUES. NO. 1.—I see on page 241 of your December issue mention of the Ganz system which the South-western Traction Company, of London, are putting in. Can you tell me how this system works?

ANS.—The Gans system of electric railway propulsion consists of alternating current motors, of the induction type, connected in concatenation; that is to say, in series. When an induction motor, with a short-circuited rotor, is connected to a source of power, the speed is practically synchronous. If, however, the motor rotor is provided with collector rings and a straight alternating current winding, similar to that of the stator, and the rotor locked, then the machine will act as a transformer, the rotor winding giving out alternating current of the same frequency as applied to the stator. If the rotor be allowed to run at half synchronous speed, then the frequency of the current which it gives out will be half that of the circuit to which the stator is connected. This is the principle of concatenation, as used with induction motors. In the Ganz system, two motors are supplied, the first being equipped with collector rings on the rotor, and the second having a short-circuited rotor. With the rotor winding of the first motor short-circuited, it will run at synchronous speed when connected to the line, as will also the second motor. To get a constant half speed, however, the stator winding of the first motor is connected to the line, and the stator of the second motor is connected with the rotor collector rings of the first motor. Intermediate speeds are obtained by means of auto-transformers, or other similar devices. In the system to be adopted in London, the trolley voltage will be either 1000 or 2000. For this particular installation a novel feature has been introduced, and that is the motors will also operate on 550 volts direct current, with the regular series-parallel control. If direct current be passed through the stator winding of an induction motor, definite poles will be produced, similar to a certain extent to the poles of a direct current series motor, though perhaps being greater in number. This fact is made use of when the motors are on the direct current circuit, the stator winding acting as the field winging of a straight series motor. The armature arrangement differs materially from anything which has heretofore been placed on the market. It is practically a double armature, having an induction motor winding and a direct current winding with a commutator, both windings being entirely separate. Thus the motors can be converted at will into either straight series for direct current or concatenated induction for alternating. For running in the city of London the direct current will be used, while for the long lines outside the alternating will come into play.

QUES. NO. 2.—A barbed wire fastened on the tops of poles with staples, strung over a high voltage transmission line, has given considerable trouble breaking off at the staples where rust has weakened the wire. Would you recommend that it be all taken down? Has this method of protection proven satisfactory? Are new transmission lines still using barbed wire for protection?

ANS.—The reason that you have had trouble with the wire breaking at the staples is that in putting it up, the staples have cut through the galvanized surface of the wire, and thus exposed the bare iron to the action of moisture. With this weakening caused by rust, there may be combined the possibility that the wire is stretched too tight. If these breaks occur frequently, we certainly think that you will be repaid by taking the wire down altogether, for such breaks will, we think, mean short-circuits, and possible damage to the line and power house apparatus. If, in your particular case, the barbed wire really affords some protection, it will undoubtedly pay to replace the old wire with new, care being taken to see that it is properly put up. The protection which is given a transmission line by stringing on the same poles a grounded wire, is very questionable. Many prominent engineers hold that the scheme is a good one, and cite instances, to sustain their views, where plants which were bothered by lightning to a great extent were almost entirely relieved when a grounded wire was strung. Other equally clever men have held that the barbed wire is nothing but a source of continual trouble, and that it cannot be of any real use. Generally speaking, it seems that in one locality the grounded wire is of value, while in others it is useless. That is the consensus of opinion on the subject, and the engineers who have in the past held and expressed radical views on the subject, are now modifying their opinions. However, taking all the new plants as a whole, it is a very noticeable fact that in the majority of cases the grounded wire is left out.

QUES. NO. 3.—What protection from lightning would you recommend for telephones where the lines are run on the same poles as a high tension transmission line?

ANS.—Practically nothing can be done out on the line itself, the terminals being the best point for the application of proper protective apparatus. There is a device made by several companies, which consists of a fuse and a small lightning arrester of the telephone or telegraph type. The fuse should be of the enclosed style, made for a voltage the same as carried on the transmission line, and should be as small in capacity in amperes as can be used, or obtained. The lightning arrester consists of two little carbon blocks, pressed together by springs, and just separated by a thin sheet of mica, the mica having several holes cut in it. This makes an arrester that will discharge very easily, and the device should be connected with the fuse between the line and the arrester. This scheme will also be a very serviceable protection in case the telephone line becomes grounded with the high tension line. We would strongly recommend, while on this subject, that a well insulated stool be provided before each instrument, and that no one be allowed to talk who is not standing on this stool. Another thing which will tend to prevent accidents is to make a strict rule that when using the 'phone, one hand only is to be employed for the necessary manipulations.

QUES. No. 4.—Does the deflected pointer on a G. E. three-phase electrostatic ground detector indicate that the line wire connected to it is the grounded wire? Please explain the action of this type of ground detector.

ANS.—On the three phase meter mentioned there will never be a deflection of one needle only. In the case of a ground existing on one wire, two of the needles will point to the segment to which the grounded line is connected, and the third needle will be at zero. If two of the lines are grounded, one needle will point to one grounded segment, and one to the other grounded segment. The needle between the two grounded segments will point to zero provided that the grounds are of equal resistance; if, however, they are unequal, then the third needle will point to the segment attached to the line having the ground of lower resistance. If you will refer to Question No. 1 (a) of our January issue, you will find a rough description of an electrometer. The static ground detector works on the same principle—if two plates are charged with electricity of opposite polarity, they will have a tendency to come together. In commercial instruments, the plates are made stationary, as in this manner it is easier to effect a good insulation. A third plate or vane, so suspended as to swing easily, is placed near the two stationary plates, but hanging so that it is between and not across them. When a potential is applied to the stationary plates, the moving vane tends to take a position across them, thus in reality doing the same thing as if the two plates moved together—the actual distance through the air between the two plates is shortened.

PARALLELING THE LARGEST TURBO-ALTERNATOR IN SERVICE.

In the latter part of December, 1904, a 5,500 kw., 25-cycle, turbo-generator built by the Westinghouse Co. was put in operation in the Seventy-fourth Street station of the Interborough Rapid Transit Company, New York. It was the first Westinghouse unit of this size to be put in service, although a number of similar machines are approaching completion. The next day after this machine was put in service, it carried loads as high as 8,000 kw., and for considerable periods loads between 7,000 and 8,000 kw. were of common occurrence. This turbo-generator is the largest now in service.

Within a few days after the machine was put in service, and while operating in parallel with six of the slow-speed, 5,000-kw. machines in the same station, a short-circuit occurred among the main leads at a point between the turbo-generator and the switchboard. This was a dead short-circuit and it tripped the automatic switches on all the slow-speed machines, which were set at almost three times full-load current, but did not trip the safety switches on the turbo-generator on account of the fact that the arc was so violent that it burned off the leads to the safety devices for this particular machine, though these leads were in a separate conduit. It was necessary to cut the turbo-circuits off by hand and the short-circuit therefore continued on this machine some little time before it was cut out. Careful examination of the generator showed that it was absolutely uninjured in any way, as far as could be determined, and was ready for service immediately afterwards, but could not be thrown in with the other machines on account of the main leads to the switchboard being burned off. The machine has been in service with heavy loads since these leads were replaced.

The 5,500-kw. turbo-generator is run in parallel with the other machines in the station and the only notable difference in its operation and that of the slow-speed machines is due to the difference in the speed regulations of the two types of engine. The steam turbine was adjusted so that it regulated much more closely in speed than the slow-speed engines and, in consequence, the turbo-generator takes the fluctuations in load. It is noted that when the turbo-generator is operating in parallel with the slow-speed machines, that the latter machines carry a much steadier load than when the steam turbine is cut out, the turbine unit appearing to take all the fluctuations when it is in circuit. This unit, therefore, has something of the effect of a fly-wheel or a storage battery on the system. This effect, if considered undesirable, can be modified readily by adjusting the speed characteristics of the steam turbine.

On account of its uniform rotative velocity and its relatively large fly-wheel capacity, the turbo-generator is particularly suitable for operating rotary converter systems such as the Interborough. Such machines also operate extremely well in parallel, and the operation of a steam-turbine unit with a reciprocating unit is, in general, considerably better than reciprocating units with each other, due to the fact that the mean rotative velocity of the combined units is better than in the case of reciprocating units alone. In the case of the Interborough slow-speed generators, this effect is not noticeable, as there is no evidence of periodic speed fluctuations in the slow-speed units, due to a large extent to the heavy dampers on the machines, their large fly-wheel capacity, and the proportions of the engines which are designed for very small angular variation.

Some months ago a series of tests was made to determine the paralleling qualities of turbo-generator units. At full voltage the machines ran perfectly in parallel. Fluctuations in speed were so slight that periods from one to fifteen seconds could be obtained for synchronizing. When the voltage was reduced to 60 per cent. of the normal, the machines would carry the full current without any evidence of hunting. The voltage was further reduced and tests were made, until about 15 per cent. of the rated voltage was obtained. Under these conditions the machines still remained in parallel when carrying full-load current, but the conditions of paralleling were not perfectly stable, the load being transferred from one machine to the other at an irregular but not rapid rate. As the synchronizing power varies approximately as the square of the voltage, it was extremely low in the last test cited. It is evident, therefore, that but small interaction is required between such machines to maintain parallel operation.—From the Electric Club Journal, Pittsburg.

The test of a 30 h.p. Diesel engine, reported some time ago in the "Mechanical Engineer," showed a consumption of crude Texas oil of 0.49 lb. per brake horse power hour when developing 28.6-b.h.p. and a thermal efficiency of 36.1 per cent.

MODERN CENTRAL STATION DESIGN AS EXEMPLIFIED BY THE NEW TURBO-GENERATOR STATION OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.*

By I. E. Moultrop.

The Boston Edison Company's system supplies electricity to a heavily loaded business section of the city, which covers a comparatively small area located within a mile of the water-front. This business is supplied by a direct-current station on the water front, having 10,500 kw. of machinery, with room to increase the capacity to 14,500 kw. Surrounding this business section is a city residential district where the load is considerable, although much lighter than in the business part. Here the customer receives direct current from sub-stations supplied, through motor-generator sets, from the existing alternating-current station of 9,000 kw. capacity, located on the L Street property. The output of these sub-stations being direct current, they are, with one exception, equipped with storage batteries.

Within the last two years the Boston Edison Company have purchased the property of many local companies in suburban places, and in most instances are changing the stations to modern alternating-current sub-stations, making a suburban business which extends in various directions from 12 to 30 miles outside of the city.

This large increase in suburban territory, together with the rapidly-growing city business, called for an immediate enlargement of the alternating-current station which was already loaded to its full capacity. A new station was therefore planned with an ultimate capacity of 60,000 kw., to be built on the L Street property alongside the existing station. The first installation of 10,000 kw. is just being completed. The old station naturally merges into and becomes a part of the new station.

The value of real estate being small, it was considered cheaper to spread out the buildings on the ground than to carry them up in the air to an equivalent area.

The turbine-room, when completed, will be 650 feet long, 68 feet wide, 56.5 feet high, and without a basement. The boiler-house will be 640 feet long, 149.5 feet wide and of the same height as the turbine-room. The arrangement of the boilers practically divides this building into seven fire-rooms.

The switch-house will be 605 feet long, 30 feet wide, and several stories high. The buildings for the installation of 60,000 kilowatts of machinery cover about 160,000 square feet, which is equivalent to about 2.67 square feet per kw.

In designing this station the grouping of the apparatus has been given special attention and care has been taken to so arrange them that they naturally come under the charge of the class of operators best fitted to care for them. The turbine-room has received all of the machinery in the station ; even the boiler feed-pumps usually considered an adjunct of the boiler-house are treated as part of the turbine auxiliaries, and are placed in charge of the turbine operators. The boiler-house contains only the boilers with the necessary piping, etc., so that the work in this room is to burn coal properly and maintain the steam pressure.

All of the electrical apparatus has been grouped together and installed in a separate building adjoining the turbine-room.

The apparatus is installed on the unit system. In the turbine-room all the auxiliaries required for a generating unit are grouped around that unit and are generally of sufficient capacity to serve that unit alone. The boilers necessary to supply the generating unit are in one row directly behind the turbine. In this way each generating unit is a small central station in itself. Practically no cross-connections are installed between the various units except that between each pair of units. The steam mains are joined by a small-sized tie so that a generating unit can be run temporarily from the boilers of its mate, shonld an emergency require. In this way a very simple piping system is sufficient, reducing the cost of installation and maintenance, and simplifying the manipulation of the station under emergencies when the engineer has to think quickly, and when he must be sure that the manipulations are made rapidly and correctly.

Before determining upon the apparatus to be installed in the station, careful consideration was given to the respective merits of turbines and reciprocating engines as prime movers. The advantages of the turbine over the engine in first cost, the lesser amount of help required to operate, the ability to use condensed steam with safety for feed in the boilers, together with the fact that the apparatus takes very much less room , decided the question in the favor of the turbine. These considerations were held to justify the decision without regard to the water consumption, and the decision will be considered wise even though the water consumption proves to be no better than that of a good engine, although it is expected to be better. Another important feature is the ability to start an idle unit quickly. The earlier turbines were open to improvement in this respect, but the later machines have been safely started and brought up to full load with remarkable speed.

The turbines used in the first installation are of the Curtis type with a rated capacity of 5,000 kilowatts on a conservative temperature rise in the generator. They are four-stage machines with surface condensers built in their bases and are equipped with mechanical brakes for bringing the machine to rest for an emergency stop. In these features they are the first machines of their kind to be installed. The base condenser was adopted because it will give a somewhat better vacuum in the turbine, which is an important consideration in turbine work. It also considerably reduces the floor space required for the installation, somewhat simplifies the piping, and makes possible a more symmetrical and pleasing grouping of the machinery. Its disadvantage is that it increases the height of the turbine a few feet, which is, however, of little moment. Its first cost is somewhat more than an independent condenser, which may be partly balanced by the saving in piping ; and it requires special arrangement for filling the condenser tubes with water when the turbine is to be non-condensing.

The brake is very useful for emergency shut-downs, because the turbine will run for some hours with no load and no field, while with the brake it is possible to bring the machine to rest in about five minutes. It also facilitates the overhauling of the step bearing by sustaining the weight of the rotating parts.

The generator is a three-phase alternator, Y-connected, 60-cycle machine, generating at 6,000 volts. This number of cycles was determined upon because the bulk of the alternating-current business is lighting, and also for the reason that the existing alternating-current apparatus has the same number of cycles.

The auxiliaries for each turbine consist of a circulating-pump, a wet and a dry vacuum-pump, a step-pump, a hydraulic-accumulator, and the boiler feed-pump for the group of boilers connected to the turbine. All these machines are steam driven with the exception of the wet vacuum-pump, which is motor driven because its speed is too high to be conveniently handled by an engine. Careful consideration was given to the subject of steam versus electrically-driven auxiliaries, and steam was determined upon because it gives better station economy. All the exhaust steam from the auxiliaries is carried to the feed-water heater and is condensed in heating the boiler-feed. The condensation is then discharged to the sewer,as it contains too much cylinder oil to warrant trying to purify it.

The circulating water-pump consists of a centrifugal-pump driven by a simple high-speed engine with a throttle governor.

The distinctive feature of the dry vacuum-pump is that the air-cylinder is placed at a right angle to the steam-cylinder, thus giving a better turning moment on the crank, and it takes less room.

The step on the turbine is lubricated by water instead of oil, because the water is as good a lubricant for this purpose, is cheaper, and the lubricating system simpler. The water is forced into a step under a pressure of about 1,000 lbs. by a steam pump of similar design to the boiler feed-pump. As even a momentary stoppage of the water supply to the step would result in damage to the bearings, a motor-driven triplex-pump, which can be started much quicker than a steam-pump, is installed as a relay to the main step-pump. To obviate fluctuations in the pressure due to the pump reversing its stroke, a weighted hydraulic accumulator is used. This is made of sufficient capacity to keep the step supplied with water for ten minutes, thus giving time either to shut down the turbine by means of the brake or to put the relay pump in service, should the steam-pump fail.

The condensing apparatus is designed to condense 153,000 lbs. of steam per hour and maintain a 28-inch vacuum in the condenser, with the cooling water at summer temperature of 70 degrees Fahrenheit. The cooling water is conveyed to the pumps by brick tunnels running under the center of the turbine-room, at such grade that they are always flooded, and constructed within the building so that the machinery can be installed above them. For additional insurance, two tunnels are provided for the incoming water, each supplying one-half the station. The notable feature of this system is the intake construction at the sea wall. Racks and screens, provided to keep out all floating material, are so installed that they require very little cleaning, and the screens are arranged to be easily removed and cleaned without permitting debris to pass into the tunnels. Where the tunnels join the screen chamber, heavy timber gates are provided so that the tunnels may be pumped dry for inspection or repairs.

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*Abstract of a paper presented before the American Institute of Electrical Engineers, New York, January 27, 1905, and reviewed for discussion before the Toronto Branch by Mr. R. T. MacKeen, February 10, 1905.

The rows of boilers are placed in pairs alternately face to face and back to back, with a chimney for each pair midway of the row and between them. Thus six chimneys in all are required, each being 230 feet high above the level of the grates, or sufficient to dispense with forced draft. Building the chimneys between the rows of boilers considerably increases the ground area of the boiler-house, but the additional space is very useful for work-room, toilet-rooms, etc. The boilers are elevated from the ground to provide liberal space beneath for ash handling. Large brick chambers immediately below the boiler furnaces collect the ashes, and discharge through valves in their bottoms into carts or cars on the ground floor. Other distinctive features of the boiler-room are the provisions for bringing air to the furnaces, the location of the piping mains, and the small capacity of the coal-bunkers.

The grouping of boilers and turbines which has been adopted gives a smaller amount of piping than would be the case were the boilers placed in the usual manner in two rows, parallel to the turbine-room,and makes a very short smoke-flue with a minimum amount of reduction in the draft.

The amount of superheating, 150 deg. fahr., was made conservative to be sure that the temperature would not cause trouble with flanged joints and in the steam cylinders of the auxiliaries. The attached type was selected because they took no additional room and are self-regulating. Use of superheaters at the direct-current station shows a gain of about 90% per 100 deg. fahr. of superheating in the engine economy, and while with the attached type it is impossible to make comparative tests with and without superheaters upon the same apparatus, the station economy indicates a substantial net gain by moderate superheating.

No economizers have been installed because of their doubtful value under the operating conditions of this station and of their effect on the chimney draft,which is liable to cause a reduction in the capacity of the boiler plant at the time when the maximum is needed, or else make it necessary to cut the economizers out of commission at a time when they would be most useful.

The storage of coal is a very esstential feature of a large central station, and is seldom adequately taken care of. Alongside of this station and adjacent to the water front an open-air storage of from 60,000 to 70,000 tons of coal is provided where the coal is stored without any shelter and immediately on the ground. The coal-wharf is equipped with an electric tower, operating a one-ton clam-shell bucket and one electro-hydraulic tower operating a similar bucket of 1.5 tons. The electro-hydraulic tower is a new design in which hydraulic-elevator cylinders furnish the power for operating the bucket. The water pressure is obtained by a three-stage centrifugal pump driven by an induction motor.

The water-supply for the boilers is of equal importance to that of the fuel. Water-service pipes of ample capacity for the total station are brought into it from large mains in the two adjacent streets. These will shortly be fed from separate trunk mains. For a further safeguard to the water-supply, a system of storage-tanks, with a combined capacity of 50,000 cubic feet of water or sufficient to run one turbine on the condenser for about ten days, is installed on the ground alongside the station building and at an elevation considerably above that of the feed-pumps.

We now come to the general arrangement of the switching. There are of necessity three bus-bar pressures, the excitation, and the possibility of a fourth pressure being required later. The engine-driven alternators generate, as stated above, at 2,300 volts, and the turbine-driven alternators at 6,900 volts. This latter was fixed upon after careful consideration of the location of the present business with reference to the station and of its probable growth. There is also a certain amount of 4,600-volt business which crept into the system some time previous because a considerable amount of business developed at a distance too far away for the economical use of 2,300 volts, and the standard cables on the system would safely carry only 5,000 volts. Therefore, the simplest expedient at that time was to install two-to-one transformers and supply them from the old station bus-bar. This business, which started in a small way long before a turbine station was considered, had grown to a considerable size at the time the turbine was installed, and the loss in the underground cables and other apparatus—which would have no commercial value in case this pressure was changed—prohibits making any change at the present time. The turbine pressure of 6,900 volts promises to be ample for the present needs of the company, but it can be easily foreseen that should the lines be extended beyond their present limits or should the business at theend of some of the transmission lines materially increase, this pressure might be too low. If this happens, it is planned to double the pressure on the transmission lines in question and transmit in these instances at 13,800 volts. All transformers installed on these lines are built with 13,800-volt taps.

The bus-bars in each system are installed in duplicate, and so arranged that they can be cut into short sections of no more than 10,000 kw. each by tie-switches, and any transmission line or generator can be isolated if it is desired to do so. Transmission lines are grouped with the generators on a section of bus-bar so that this bus-bar does not have to carry much current any distance lengthwise. The generator is connected to the bus-bars through one main-switch and two selector-switches. These switches are designed to open under the full station capacity, should emergency ever demand it. The transmission lines have selector-switches but no main-switches at present, space being reserved for the installation of selector-switches should they prove desirable later.

The switches are all installed on the third floor of the switch-house. The selector-switches are in two rows. Each row consists of two switches (placed back to back) running through the center of the building and immediately over the bus-bars they connect to. The main-switches are installed in two single rows, one on each side of the switch-house and against the side walls. On the floor below, the bus-bar compartments are arranged similarly to the selector-switches, two rows of two through the center of the room. In two single rows on each side wall immediately under the main-switches are grouped the instrument transformers in special compartments.

The oil-switch cells, the bus-bar chambers, and the instrument transformer chambers are all built of a light-yellow brick with a fine cement joint, the brick being selected for its low absorption properties. The barriers in the bus-bar compartments and also in the instrument compartments are of reinforced concrete with a fine, close-grained finish. These are all made in moulds and set in place similarly to slabs of alberene; they have as good insulating qualities as alberene with less absorption, are much cheaper, and furthermore are less liable to break. The bus-bar chambers are fully enclosed, small doors being left in the wall for access to the connections only. The instrument transformer cells are left open. The front of each switch-cell is enclosed with a wooden frame filled with a pane of glass which permits an inspection of the pot, while at the upper part of the frame there are a few slats for ventilation, and for vents in case of an explosion.

AGE LIMIT FOR BOILERS.

The plates of an old boiler that had been in use since 1859 exhibited, on tests of 812 test-pieces cut from it, a marked lack of elasticity. According to the report in the *Zeitschrift* of the Society of German Engineers, the boiler had been fed with pure water and never over-strained, so that it was concluded that its unsatisfactory condition was the result of prolonged stress, and that subjecting it to a strain might have led to an explosion. It was felt that the test showed that a boiler should be discarded at the end of 35 years' service and even if apparently in good condition should be replaced by a new one.

Mr. C. J. Brown, City Clerk of Winnipeg, Man., is asking for tenders up to February 13th for snpply of two 250 h.p. water tube steam boilers for the city waterworks.

The latest addition to the list of trade journals of this country is The Canadian Machine Shop, published by Messrs. Biggar, Samuel Limited, of Toronto and Montreal. As the name implies, it is devoted to machine shop practice, mechanical engineering,foundry work,drafting and pattern making, and the first issue shows it to be a thoroughly practical journal. It is published in magazine size and contains seventy-six pages, the subscription price being $1 per year.

ELECTRIC LIGHT INSPECTION.

The report of the Inland Revenue Department just to hand furnishes the particulars of electric light inspection in Canada during the year ended June 30th, 1904. The fees for the inspection of meters were $18,823.75, while for registration of companies there were received $4,435, making a total revenue of $23,258.75. The expenses of inspection were $6,204.63 and there was expended on instruments, etc., $1,842.37, leaving a net revenue of $15,211.75. The report states that since the year 1896-97 the two services of gas and electric light inspection, which are conducted largely by the same staff of officers, have reached that point at which they have ceased to be a burden upon the general taxpayer, as shown below :—

Year.	Gas and Electric Light. Revenue.	Gas and Electric Light. Expenditure.
*1899-1900	$35,523.50	$26,424.48
*1900-01	37,536.57	28,247.20
1901-02	45,663.05	33,328.48
1902-03	49,054.55	36,006.47
1903-04	50,218.75	33,426.15

*Exclusive of cost of standard instruments.

There were presented for inspection 15,576 meters, of which 15,500 were accepted as coming within the error tolerated by law; 66 were rejected, and 8 were verified after first rejection. In the previous year 124 meters were rejected and 28 were verified after first rejection. The details for the fiscal year ended June 30th, 1904, follow:

Districts.	Number Presented.	Verified as within the error tolerated by law. Correct.	Fast.	Slow.	Rejected. Unsound.	Fast.	Slow.	Verified after first Rejection. Correct.	Fast.	Slow.
Belleville..	315	132	67	116	....	....	....	....	....	....
Hamilton..	810	263	238	306	2	....	1	....	....	....
London...	795	261	270	261	....	2	1	....	....	....
Ottawa....	2,135	441	231	1,460	2	....	1	....	....	....
Toronto...	2,308	573	946	778	....	9	2	....	....	....
Montreal..	2,702	1,683	868	124	5	5	17	....	....	....
Quebec....	987	320	634	31	....	....	....	....	1	2
Sherbrooke.	41	10	16	14	....	1	....	....	....	....
St. Hyacinthe	99	98			1	....	....	....	....	....
Three Rivers	39	12	13	14	....	....	....	....	....	....
St. John....	1,052	455	309	280	....	2	3	....	....	3
Halifax....	611	551	23	22	5	3	5	2	....	....
Charlottet'n	158	52	67	38	1	....	....	....	....	....
Winnipeg....	1,320	923	151	246	....	....	....	....	....	....
Vancouver....	1,332	302	255	775	....	....	....	....	....	....
Victoria....	802	371	192	239	....	....	....	....	....	....
Total....	15,576	6,516	4,280	4,704	16	22	30	2	1	5

There were registered under the Electric Light Inspection Act 340 companies, an increase of sixteen over the previous year.

A cable road nearly 4,000 feet long forms part of the electric traction system of Palermo, Sicily, to assist the cars over a grade averaging 12 per cent., with 13.17 as a maximum for about 650 feet. The cable passes around a wheel fixed at the top of the grade, and each end is attached to an electric locomotive weighing 8.7 tons. In operation a car is coupled to the locomotive at the top of the incline and another car to the second locomotive at the bottom, and the two pass at a turnout at the center. At the bottom the locomotive descends into a pit between the running rails for the cars, the rails for the locomotives lying between the others. The car to be hauled upward passes over the locomotive, so that it can be on the upward side of the locomotive on reaching the upper limit of travel. One car descends as the other ascends.

MONTREAL

Branch Office of The Canadian Electrical News,
38 Alliance Building.

February 8, 1905.

The past year might have been better among the electrical fraternity in Montreal. Several happenings told against local business, such as the late spring in 1904, followed by trade strikes in the building line; then a comparatively cool summer—killing fan motor sales. In the fall, when building became active again, operations were hampered by continuous rainy weather.

After one of the hottest fights on record the real estate proprietors of Westmount, the western suburb of Montreal, voted permission to the Town Council to establish an electric light plant if more favorable terms cannot be procured from the present contractors at the expiration of their present contract. Messrs. Ross & Holgate were the electrical engineers employed by the town to report on the scheme.

The Royal Victoria Hospital had the misfortune to have a fire in the Administration building. For *once* the daily press did not put it down to "electric wires." Great credit is due the staff of the Bell Telephone Company for prompt resumption of their service in and from the institution. The local switchboard was situated two flats under the kitchen, where the fire originated, and was consequently damaged by water. The cause of the fire was ignition of a large vessel of cooking fat, by the range.

A slight damage by fire occurred lately at the Shawinigan step-down station operated by the Montreal Light, Heat & Power Company. The cause is given as a short circuit. The local fire brigade might have extinguished it with the aid of a Babcock, but instead got a stream from a hose playing on it which caused considerably more damage than the fire itself.

The Central Electric Company, who have lately opened up for business on St. Peter street, Montreal, for the supply of light and power, is largely owned by Mr. S. Carsley. Mr. Carsley has been happy in his choice of a manager, having secured Mr. Chas. Morton, lately the popular manager of the Temple Electric Company. The Central Company operate at 220 volt d.c. The plant is run by steam power, the engines and dynamos being both of English construction, and running with remarkable freedom from any vibration. Several good contracts have already been secured.

The Electrical Contractors' Association has, through general apathy and lack of interest of its members, become dormant. No meetings have been held for a considerable time, and although it cannot actually be called "dead," yet it certainly has fallen into a deep sleep Financial troubles did not exist, and no blame can be laid to lack of funds. One factor was the intense competition, which caused many to believe they would be binding themselves to some conditions which might mitigate against their business, and hence stood aloof. No such conditions, however, existed, and it is a pity that such an association, formed purely for common defense and the furtherment of the trade, could not be made a live interest.

The breakdown of electrical machinery has been investigated by the Engine, Boiler & Employers' Liability Insurance Company, of Great Britain. The report for 1903 shows that 14 and 12 per cent. of the breakdowns were due to accidents, the first figure being for dynamos and the secound for motors; that 10 and 15.5 per cent. were attributed to dirt and oil; that 24 and 19 per cent. were the result of age and deterioration; that 3.5 and 5.5 per cent. arose from overloading; and 13 and 29.5 per cent. were not ascertained, the figures throughout being for dynamos and motors, respectively.

The new electric lighting system which is owned and controlled by the city of Moose Jaw, Assiniboia, is now in effective operation. The electrical apparatus, including the generator, switchboard, pole line and wiring system, was supplied by Allis-Chalmers Bullock, Limited, Montreal. The generator is a 2 phase 2200 volt, 100 k. w., Bullock revolving field type. The power house is equipped with a tandem compounding condensing engine of 160 h.p., built by the Robb Engineering Company, of Amherst, N. S. When the pumps are installed the cost of the building and machinery will be in the neighborhood of $38,000. The whole equipment is thoroughly efficient and modern.

TELEGRAPH and TELEPHONE

TELEPHONE EXTENSION IN WESTERN CANADA.

The Bell Telephone Company contemplate extending their system to reach a number of new towns and villages in Western Canada during the present year. The work already planned is as follows: Along the Glenboro branch wires will be run from Winnipeg to Souris reaching all points on this line. From Portage la Prairie the company will extend their system northwest to Neepawa, through Westbourne, Gladstone and Arden. From Killarney the wires will be run to Deloraine, affording long distance communication to Ninga, Boissevain and Whitewater. Lines will also be built from Winnipeg to Stonewall, from Brandon to Hamiota, from Brandon West to Moosomin, and from Regina to Indian Head, the latter extension connecting Balgonie, McLean and South Qu'Appelle with Regina. In addition to the towns already named, the company will serve the following points not already reached by the service, on the Glenboro branch: Starbuck, Fannystella, Elm Creek, Rothwell, Treherne, Holland, Cypress River, Glenboro, Stockton, Wawanesa, Nesbitt and Carroll. Between Brandon and Hamiota the following important points will be reached: Forrest, Carnegie, Rapid City, Oak River, and Hamiota. West from Brandon to Moosomin, Griswold, Oak Lake, Virden, Elkhorn, Fleming and Moosomin will be reached. A branch line will also be built from Lariviere to Snowflake, connecting south with the American system at Hannal, North Dakota.

If the season will permit, the connecting link between Moosomin and Indian Head will also be completed this year, affording direct connection between Regina and Winnipeg.

The Bell Telephone Company have recently purchased six lots on Henry avenue, running to Fonseca, in Winnipeg. It is the intention to build on this property a stores department, repair shops and stables, the plans for which have already been drawn.

GLASGOW'S MUNICIPAL TELEPHONE SYSTEM.

Of the municipal telephone systems of Great Britain only one, that at Glasgow, has been in operation long enough for the errors of finance and installation to come fully to the surface. The Glasgow system has been in operation for four years. The time is so short that had the plant been all that the ratepayers should have received for their money it should have been to-day in a fairly satisfactory condition. Instead of this the defects are developing with alarming rapidity, and the efficiency of the service has become so greatly impaired that to-day complaints regarding it are very frequent. The defects are not due to the fact that too little money was spent in its installation. The estimate on which it was decided to construct the system called for an expenditure of, without contingencies, £16 14s. per subscriber's line. The 1904 accounts show the average cost per line to have been £30 15s. or over 80 per cent. in excess of the estimate.

The estimates called for all cables being laid in conduits, whereas in the plant as constructed about one-third of the total length of cables is armored cable buried solidly in the ground, hundreds of pounds having thus been saved at the cost of efficiency. This is in itself a serious matter, but it pales into insignificance in comparison with another grave defect. The original installation was on the wall-wire system, a method out of date at the time in all first-class plants. Glasgow discovered this after the money had been spent, and an extension being necessary another system was adopted and then another, and so on, until to-day there are in the various exchanges no less than five different systems employed. Naturally the effect has been complications and a bad service. In the last official report the telephone committee reported that they had under consideration a change in the method of operation, and quite recently manufacturers have been invited to submit estimates on the cost of changing all the central office equipment and subscribed instruments to give automatic calling and clearing. The approximate cost of this change is estimated at £35,000. But at the best this would only mean a patch-work job. To completely reorganize the plant and bring it up to date would require the scrapping of plant that cost about £90,000 and the expenditure of a larger sum.

It would appear, therefore, that Glasgow has spent about twice as much as originally intended, and for the expenditure has a plant that is far from being what it should be.

Early in 1903 the Glasgow municipal plant and the National Telephone Company had approximately an even number of stations. But the municipal service was bad, and growing more and more unsatisfactory, with the result that during the last year the great proportion of new business has been going to the National Company, so that at the present time it has 18,048 stations as compared with 11,822 of the municipal service. The value of a telephone depends largely upon the number of connections that can be secured, and the National being able to give its subscribers 50 per cent. more connections and a better service, the municipal service would appear to be in a more or less precarious position.

SHORT CIRCUITS.

The Bell Telephone Company have opened a new exchange at Virden, Man., with sixty subscribers.

The Bell Telephone Company are installing a new switchboard in their exchange at Prince Albert, N. W. T.

The City Council of Winnipeg, Man., have appointed a committee to report upon the question of establishing a civic telephone system.

Mr. A. Mallory, formerly manager of the C. P. R. Telegraph Company at Calgary, N. W. T., has been appointed circuit manager at Winnipeg. He is succeeded at Calgary by Mr. T. J. Fitzgerald, of St. John, N. B.

The British Columbia Telephone Company, of Vancouver, are endeavoring to secure a franchise in Fernie, B. C., but the council seem to favor the application of a local company represented by Hammond & Turner.

The Bellechasse Telephone Company, of Levis, Que., have applied to the Legislature for power to increase the capital stock to $250,000 and to manufacture and deal in apparatus used in connection with telephones.

The Canadian Machine Telephone Company are installing the underground cables in connection with their systems at Peterboro, Ont. The work is in charge of Mr. P. Melville, Canadian superintendent of the Standard Underground Cable Company.

The Central Dufferin Telephone Association, Limited, of Shelburne, Ont., purpose extending their line about four miles into Amaranth Township, and may also build a line to Black's Corners, a distance of seven miles. Dr. R. W. Rooney is president of the company.

Telephone mistakes may have their serious sides. A man who wanted to communicate with another named Jones looked in the directory and then called up a number. Presently there came through the receiver a soft feminine "Hello!" and he asked: "Who is that?" "This is Mrs. Jones." "Have you any idea where your husband is?" He couldn't understand why she "rang off" so sharply until he looked in the book again and discovered that he had called up the residence of a widow.

The annual meeting of the shareholders of the Central Telephone Company was held at Hampton, N. B., on January 25th. The report of the secretary-treasurer showed that 156 miles of line are being operated, reaching thirty-nine different points in Kings and Queens counties. Plans for further extension and wider operations were introduced and discussed, and it is understood that it was decided to apply for a provincial charter and engage in a general telephone business, special attention to be given to the automatic system. The officers elected for the current year are as follows: President, T. H. Estabrooks, St. John; vice-president, S. H. White, Sussex; secretary-treasurer, H. P. Robinson.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Panel-Boards for Office Buildings.—Systematic arrangement of circuits, avoiding all confusion such as often results in the wiring of large office buildings, is the result of a new type of panel-board installed in the great Railway Exchange Building in Chicago, Illinois. The panel-board is compact, and at the same time gives great flexibility in connecting the various circuits in the building to the metering system. The general arrangement and connections of the device are shown in the accompanying illustrations reproduced from the Technical World. The board is mounted on a shallow steel box and is divided into two sections, vertically (Fig. 1.) At the top the feeders from the three-wire service enter, and are led through the fuses to the main switch. The neutral passes from the switch down to two bus bars in the lower portion of the board. These bus bars are common to one side of each of the office circuits. The other side of each individual office circuit ends in a terminal on the board, and from this terminal a wire is carried up to the customer's meter, the current passing from the meter back to the other side of the main circuit, as shown in Fig. 2. In the latter figure, one of the meters is shown as registering on the two right-hand circuits at the top and bottom of the panel. When the lower one of these offices is to be vacated and the other retained, the meter can readily be changed to the one circuit by merely removing the jumper wire connecting the two, thus disturbing no other wiring.

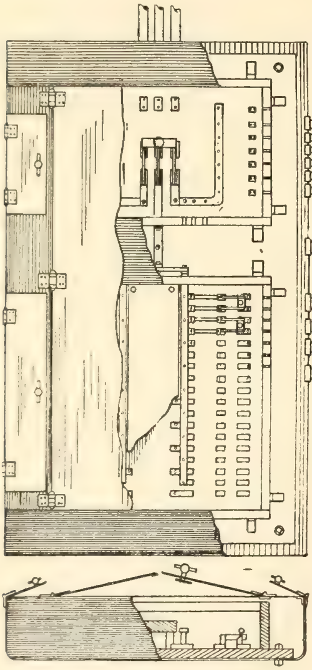

Fig. 1. Panel-Board for Office Buildings.—General Arrangement.

The wiring of all the meters served by each panel-board is brought in at the sides near the top (Fig. 1), and the lamp circuits lead out opposite their respective switches at the lower portion of the board. The wiring on both sides is identical, although Fig. 1 shows it as entering one side.

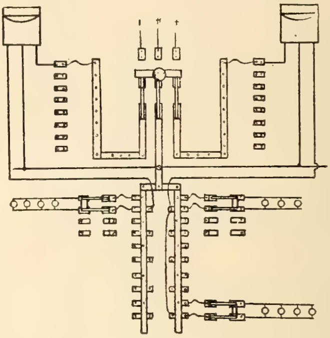

Fig. 2. Panel-Board for Office Buildings.—Connections to Meter.

Unscrewing two marble slabs at the rear, covering the fuses and wiring, gives access to the panel itself. Two small doors at the top and bottom of the case near the edge (Fig. 1) can be opened, to show at a glance which leads are connected to the respective fuses.

Westinghouse Type K Voltmeters and Ammeters.—There has been a long continued demand upon makers of electrical instruments for reliable voltmeters and ammeters for switchboard work in connection with small installations and in competitive work, that could be supplied at a price in keeping with that of the other apparatus. To fulfill this demand, the Westinghouse Electric & Manufacturing Company offers a new line of instruments known as the Type K for use upon either

direct or alternating currents. This type is a development of one of the Lord Kelvin patents controlled by the Westinghouse Company. In shape, size, finish and general appearance, the Type K instruments harmonize with the other round pattern switchboard types of the Westinghouse manufacture. Their principal distinguishing characteristic is the simplicity of their construction. There are but few parts, none of which are complicated, and the adjustments are easily made. In effect, the mechanism consists of a stationary coil, through which the measured current flows, the voltmeter measuring the current which flows through a high resistance. This coil acts on a movable core or plunger, which is connected with a steel beam mounted upon knife bearings and carrying the indicating pointer. There are no springs, the action being controlled by gravity. In other instruments in which a solenoid is employed, the residual magnetism has seriously affected their accuracy. In the Type K the core is so constructed that it is saturated with a very small amount of magnetic energy, such as that of one twentieth full scale deflection, and thus for any load the attraction upon the plunger is directly proportional to the current, making the error due to residual magnetism commercially negligible and the scale almost uniform, commencing with zero. On alternating currents its action is not appreciably affected by changes in frequency. External fields do not influence the performance, and temperature errors are negligible. The instruments are dead beat in their indications, the steadying effects of a dash pot being obtained by inserting the lower end of the plunger in a glass tube filled with oil. The opening in the solenoid is made small and the plunger is a piece of fine iron wire, flexibly connected to the movement by means of a strong silk cord. Movable weights shown at D and E in the accompanying illustration afford a means for adjustment. The sector illustrated at A corrects inequalities by keeping the leverage the same in all positions.

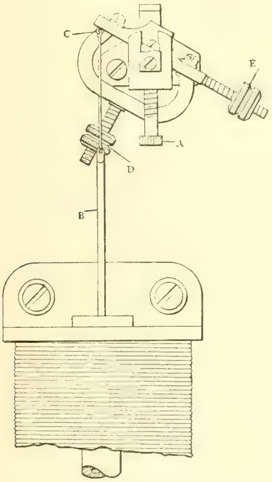

Diagram of Westinghouse Type K Instruments.

New Belt-Driven Alternator.—The General Electric Company, Schenectady, N.Y., have brought out a new form of belt-driven alternator which it designates as form P. The machine is built with two bearings which are mounted one on each end of the shaft. It is of compact design, and occupies less floor space than do machines arranged with separate pillow blocks and bearings. The bearing at the pulley end of the machine is made large, and is placed close to the revolving field spider, in order to bring the pulley close to the machine. The alternator is of the revolving field type with a stationary distributed armature winding. The poles of the field are built up of laminations, and are fitted into dove-tailed slots in the steel hub by taper keys. The field coils are made from flat copper strip, wound on edge, and are designed for 125 volts excitation. The pulley has a cast-iron centre and pressed paper rim. This type of pulley is considerably lighter, and is able to transmit more power per inch of face than an iron pulley, thus tending to increase the life of the belt and to diminish the strain on shaft and bearings.

TRANSFORMER OUTFITS FOR THAWING PIPES.

The manifest superiority of electricity as a thermal agent in thawing frozen pipes, and the field for this service that awaits development, has attracted a considerable amount of attention on the part of central station managers, many of whom have improvised outfits for this purpose. There has arisen a very general demand for thawing outfits that shall have a range in capacity to cover all ordinary requirements, shall be portable, easy to connect and moderate in price, and to meet this demand the Westinghouse Electric & Manufacturing Company have designed the two transformers herein described.

The larger of the two outfits weighs complete with transformer, switchboard and base 750 pounds. It occupies a floor space 2 ft. 4 inches by 1 ft. 10 inches, and is 1 ft. 7 inches in height. A link in the top of the transformer case affords a means of lifting the outfit, and if desired truck wheels may be attached to the wooden base. It will be seen that it is of small size and is lighter in weight than any other outfit for the same purpose, giving it a superior portability.

The transformer may be operated satisfactorily on circuits varying from 1,800 to 2,500 volts. The low tension is arranged to deliver approximately 500 amperes for several hours at an E. M. F. from 15 to 50 volts. By a simple change in connections, the windings may be arranged to deliver about 1,000 amperes at voltages from 8 to 16, for thawing large mains whose resistance is generally low. It is suitable for thawing anything from a one-half inch pipe to a one foot main.

The transformer is generously designed, and will deliver large overloads for short periods of time. The windings are air cooled. The insulation is not injured by rain, snow or ordinary abrasion. There are no moving parts to get out of order, and the entire outfit is contained in a single unit.

A light but substantial switchboard is mounted upon the high tension end of the transformer. The switches are of the enclosed plug type, such as are used upon high tension arc light circuits, and permit a variation of the low tension voltage, and consequently the current supplied to the pipes. The switches are so arranged that it is impossible to make a wrong connection.

The other transformer outfit is smaller and is particularly adapted for thawing service piping about dwelling houses. It is light, of such proportions as to make it easy to handle, and is mounted in a wooden box provided with a handle and shoulder strap. It has a capacity of 200 amperes at potentials up to 25 volts for one hour. It is arranged for operation off a nominal 2,000 volt circuit but can be supplied for any other primary voltage to as low as 200 volts. The voltage regulation and current control are obtained through plug switches in the high tension circuit.

When desired, these outfits are furnished with a current measuring device, so that the operator may know the amount of current that is being used.

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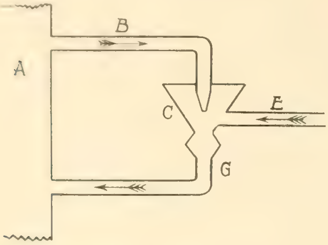
ENGINEERING and MECHANICS

THE INJECTOR.*

By E. C. Winterburn.

The injector is a mechanical contrivance by which the energy of a jet of steam from the boiler is utilized to force a stream of water back into the boiler. There are many different kinds of these instruments, but the principle is the same in all. When used for lifting water, the injector depends upon a partial vacuum being created by the jet of steam coming into contact with the cold water. In the accompanying figure this action is shown. A represents a boiler, B the steam pipe, with a nozzle-shaped end, which discharges into a cone-shaped vessel, C The steam escapes with great velocity through B, and as it passes through C, forcing the air away in its course, the water naturally follows through E, when the steam and water meet. A partial vacuum is formed, then the steam and water rushing into this vacuum-formed space increases the velocity to such an extent that it easily finds its way into the boiler. The injector most commonly used in this district is the Penberthy; other makes are numerous, slightly different in detail, but the principle remains the same in all. To ensure the good working of an injector, it is essential in fitting one to a boiler to follow the following instructions. The steam lead should be as direct as possible and from the part of the boiler where the steam is the driest obtainable; this pipe should have no other connections and should be with as few bends as possible. The suction pipe should be at least one size larger than the nipple on injector, and if the source of supply is far away, two sizes larger is preferable. This pipe must be absolutely air tight, as the slightest leak considerably affects the efficiency of the injector, just as a leaky suction affects a pump.



In long lengths of suction pipe, a non-return valve placed at a convenient distance to break the draw, will be found a great advantage, also a globe valve near the source of supply is a great convenience. A globe valve is placed close to the injector on supply pipe to regulate the water supply. A check valve must be placed on the delivery pipe between injector and boiler, to prevent the return of feed water. A stop cock is also placed between the check and boiler to enable the engineer to examine the check valve at any time when steam is up. The causes that would prevent an injector working are the the following:

1. Leaky suction.
2. Suction pipe stopped up.
3. Dirt in combining tubes.
4. Water too hot.
5. Steam too low.

Each one of these has its own specific remedy, which will readily suggest itself to the engineer in charge; but the best cure, if I may use the expression, is prevention. Each one of these defects can be prevented from causing any inconvenience if the injector is periodically examined and cleaned and all the piping tested. The mechanism of an injector being delicate and sensitive, it should be treated with care and consideration. Scale or dirt in the tubes can be cleaned off either by scraping or soaking in a solution of muriatic acid 1 part, and water 10 parts, and washing properly afterwards before replacing; as it requires 10 to 12 hours in this solution to be of any benefit, I find the former way the handiest. If the scale is not taken away regularly, the full area of the nozzles will not be obtained and the proper flow will be impeded.

When the suction pipe is stopped it can usually be disconnected and cleaned by a rod or by blowing steam through it. The injector should at all times be kept cool, which necessitates the steam valve being always in first class order, also the check valve requires attention occasionally. If these leaks are allowed there is a constant dribble and in waters where there is presence of lime or gypsum, a scale is soon formed on the working parts, increasing the friction and reducing the working area of the injector. If the injector has not an independent steam pipe, other valves may be opened, thus taking away the steam, leaving the instrument with insufficient power to drive it.

One great advantage that the injector has over the feed pump is that most of the heat used to force the water into the boiler is utilized in heating the feed water; the feed entering the boiler at a high temperature saves the boiler plates from injury by sudden contraction, which is often the case where pumps put cold water direct into the boiler, causing leaky tubes, stays, etc. It is also a great fuel saver, by introducing feed water up to the maximum of 150 degrees. The following table gives the average pressures, temperatures and lifts:

Lift in Feet.	Lowest Steam Pressure to Start.	Maximum Temperature of Feed.
0 to 3	15 to 20 lbs.	150 deg. to 140 deg.
4 " 10	25 " 30 "	120 " " 100 "
10 " 20	30 " 45 "	90 " " 75 "
20 " 25	45 " 60 "	80 " " 60 "

The steam at which injectors will work depends on the lift and temperature of water; for a 2-foot lift with 100 lbs. pressure, 145 deg.; for 150 lbs., 130 deg., and 180 lbs., 120 deg. And as the lift increases the temperature of the water must be lowered, the exact temperature being found by practice. The capacity is almost the same in all injectors under like conditions.

Size of Pipe connections.	Gallons per hr. Maximum.	Gallons per hr. Minimum.
⅜"	85	50
½"	165	75
¾"	350	130
1"	580	325
1¼"	900	425
1½"	1,750	750
2"	2,850	1,150

CERTIFICATES FOR ENGINEERS.

The quarterly examinations for engineers' certificates for the Province of British Columbia were held at Victoria about the middle of January. Of about sixty candidates, the following were successful:

Fourth class certificates—Hy. Puckle, Wm. De Rousie, J A. Sweeney, R. Noble, Thomas Cox, Wm. Freeman, W. Reinhart, A. Carlson, D. Lehman, A. Popham, G. R. Baker, D. Silemult, J. C. Renfrew, A. Berquist, P. A. McLean, R. S. Chapman, G. Underwood, L. Walton, D. Williams, Geo. Ulrich, W. S. Smith, E. Jacobson, C. D. Hawkins, T. J. Carson, T. Cragie, Chas. Cathey and R. Humber.

Third class certificates — James Taylor, J. D. Watson, F. Shade, James Laird, F. Haled, James Tyson, Wm. Graham, A. J. Neff, Wm. D. Thompson, R. D. Stephens, Chas. Hiscock, H. E. Neaves, W. C. Pettigrew, Thomas Preece, H. J. Geake, Joseph Lismore, R. G. Johnston and J. Smith.

Henry Wilson and Peter Gordon secured second class certificates.

A fourth class certificate permits the holder to operate any steam plant up to 25 horse-power; third class enables the possessor to take charge of a plant of 250 horse-power; while the second class permits the holder to be chief engineer of any plant up to 500 horse-power.

The Canadian Association of Stationary Engineers have appointed a committee to wait upon the Ontario Government and again ask that legislation be passed compelling all engineers to hold certificates.

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*Paper read before the Stationary Engineers' Association, Victoria, B.C.

SPARKS.

A plebiscite is to be taken at Charlottetown, P.E.I., on the question of operating the electric light plant under municipal control.

The Electrical Development Company of Ontario are about to commence the erection of their large power house adjacent to the Queen Victoria Park at Niagara Falls, Ont. It will be built of either cut stone or granite.

The Waterworks and Electric Light Commissioners of Campbellford, Ont., have not yet submitted their by-law to raise funds for an electric light plant, as a more extensive expenditure than was at first proposed is now being considered.

The directors of the Hamilton, Grimsby and Beamsville Electric Railway Company have under consideration a plan to extend their line four miels from Vinemount, Ont., to connect with the line of the Niagara, St. Catharines and Toronto Railway.

The Grand Trunk Railway Company are employing electricity to a considerable extent in connection with their shops at Stratford, Ont. About two years ago they put in a small bipolar dynamo connected to the main shaft to supply a few lights for the shops. One year ago they installed two McEwen high speed automatic engines direct connected to C. G. E. direct current machines of 250 amperes, 120 volts. They are now just completing the installation of a 500 h.p. tandem compound Robb-Armstrong engine direct connected to a 300 k.w., 1,200 ampere, direct current machine of the Westinghouse type, this unit being for the purpose of supplying current to a number of Westinghouse motors of 30 and 50 h.p. to drive a 25 ton electric crane, the machinery of a wheel shop, punches and shears of a boiler shop, and some planers in the carpenter shop. It is the intention to make further additions to the electrical equipment during the coming spring.

Electrical Engineer—Long practical experience in fitting up and taking charge; also estimating and consulting. J. PEARCE, New Liskeard, Temiskamieg, Ont.

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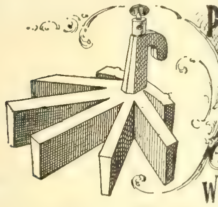

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THE OTTAWA STREET RAILWAY.

The annual general meeting of the Ottawa Electric Railway Company was held on January 30th last. The report for the year ending 31st December, 1904, showed gross receipts of $[illegible]. The net earnings for the year were $139,097.70. Four quarterly dividends of two per cent. each were declared, amounting to $[illegible]. The mileage payments amounted to $[illegible], and interest on bonds $20,000. The sum of $26,000 was placed to the credit of contingent account, to be applied to reduction of track renewal and car equipment accounts, and a balance of $[illegible] was carried forward to the credit of profit and loss.

The number of passengers carried during the year was 8,717,205, an increase of nearly one million over 1903. It was stated that a motor generator set of a capacity of 1,300 h.p. had been installed in a new power house built on Middle street and that it was giving satisfactory results. Last winter the company experienced the worst snow storms since the opening of the road, the snow clearing amounting to $20,186 for the year, an increase over 1903 of $5,701.

Owing to the large increase of summer travel, twelve new open cars have been ordered and will be ready for the opening of next season's business.

The following were elected directors for the current year; Messrs. T. Ahearn, George P. Brophy, Peter Whelan Thomas Workman, Warren Y. Soper, Hon. George A. Cox. At a subsequent meeting of directors, Mr. T. Ahearn was re-elected president, Mr. Peter Whelan vice-president, and Mr. James D. [illegible] secretary-treasurer.

PUBLICATIONS.

"The Letter of Petrus Peregrinus on the Magnet, A.D. 1269," is the title of an interesting book of an unusual character issued by the McGraw Publishing Company, 114 Liberty street, New York, and which retails at $1.50.

Two bulletins recently received from the Canadian Westinghouse Company, Hamilton, Ont., are devoted to their "Type N" transformers and their self-contained direct current multipolar generators.

We have received from Longmans, Green & Company, Paternoster Row, London, Eng., a copy of J. C. Gregory's book entitled "A Short Introduction to the Theory of Electrolytic Dissociation," the price of which is one shilling six pence.

The Westinghouse Machine Company, of East Pittsburg, Pa., have issued a book devoted to the Roney mechanical stoker, which they claim is recognized as the standard of best stoker practice and capable of meeting successfully all the arduous requirements of heavy modern service.

Mr. H. C. Cushing, jr., author of the hand book "Standard Wiring for Electric Light and Power," has just brought out the 1905 edition of this book, completely revised to date. Mr. Cushing, in revising this new edition, was successful in securing the services of Mr. F. E. Cabot, Secretary of the Boston Board of Fire Underwriters, and Chairman of the Electrical Committee of the Underwriters' National Electric Association, to assist him with that part of the book which treats of the underwriters' rules and requirements, and also the assistance of Mr. George T. Hanchett, Consulting Electrical Engineer and Member of the American Institute of Electrical Engineers, in checking up and revising many valuable tables and formulæ to aid practical wiremen and contractors in determining the proper sizes of wires for all manner of construction work for both alternating and direct currents. This new edition, like all previous editions, is handsomely bound in flexible leather, and makes a most complete and accurate pocket companion for the practical electrical engineer, central station man, wireman and contractor, as well as an accurate guide for the architect and builder, many of whom are called upon to embody, not only in their specifications but in their plans, provision for the electrical construction in buildings and structures of all kinds. "Standard Wiring" is recognized as the authority on electrical wiring and construction, being the only book on the subject which is revised and brought up-to-date every year.

The City Council of Winnipeg, Man., have instructed the City Engineer to report on the best method of obtaining power for manufacturing purposes.

Now Ready. Price 12/6. Post Free.

The Imperial Directory of

Electric Lighting & Electric Traction Works, 1905.

Edited and compiled by C. S. Vesey Brown, M. Inst. C. E., M. I. E. E.

The Directory contains a list of the works, established under statutory powers, in **Great Britain and Ireland, India and the British Colonies,** for the supply of **Electric Lighting, Power and Traction.**

The **statistics** given **for each town** are **divided** into **3 parts**:—

(a) **Names and addresses** of all the **Directors, Members of Municipal Committees and the principal Officers** connected with each works, together with their postal and telegraphic addresses.

(b) **Technical description** of each works, showing the **"system of supply,"** detailed list of the **machinery, storage cells, cables, meters, etc.,** with which the **works are equipped,** giving the **makers' names** in each case, also **the prices charged for Light, Power and Traction.**

(c) The **financial results for the last completed year of working,** showing **capital expended, revenue and costs of generation, etc.,** are **given in detail.**

This is the **busy man's book,** it is **indispensabe to all** interested in the **Electrical Industry.**

If you are interested in Electrial Works of any description, **either as a Director, Town Councillor or Official** connected with the running of an Electric Lighting or Traction Works, then this is the book that will give you the information as to how your works compare with your friends' works elsewhere.

If you are interested in Electrical Works, **as a Supplier of machinery, or stores,** to Electrical Generating Stations, or Tramways, then **this is the book** which will tell you who is the **right man to write to** on the particular subject you are trying to sell. **You will not get any letters returned** marked "Not known at this address" **if you follow** the "directions given in this book."

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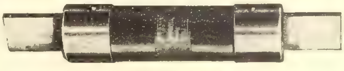

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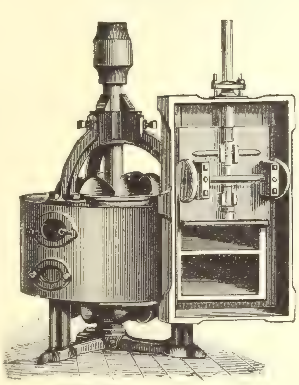

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TRADE NOTES.

The Western Electric Company, of Berlin, Ont., have just completed the equipment of a factory for the manufacture of electric meters, and are now in a position to fill orders in this line.

As announced in our advertisement pages, Mr. K. L. Aitken has succeeded The Electrical Supervision Society, 104 Bay street, Toronto, and will carry on business as a consulting electrical engineer at the same address.

Section 2 of the Supply Catalogue of the Canadian General Electric Company, Toronto, is devoted to cabinet panels, fuse blocks, cut-outs, fuses, etc. It is very complete and will be found of interest to the electrical trade.

The International Jury of Awards of the Louisiana Purchase Exposition, St. Louis, 1904, has awarded a Grand Prize to Nuernberg "Electra Carbons." The Canadian General Electric Company are sole agents in Canada for these goods.

We are advised that Mr. C. E. Shedrick, of Sherbrooke, Que., will continue for another year the general agency in Canada for the Whitney Electrical Instrument Company, of New York, for their full line of measuring devices. Mr. Shedrick also continues to manufacture a full line of measuring instruments at Sherbrooke, where he has been located for the last twelve years, with a well equipped plant. He is in a position to give the best attention to repair work on all makes of electrical instruments of precision.

The Canadian Casualty and Boiler Insurance Company, of Toronto, have made another addition to their already competant and experienced staff of engineers. The new appointment is that of Mr. Charles O. Granberg, who is regarded in engineering and insurance circles as one of the best in his class. We learn that this company had a successful year and the constant increase of their business necessitates the selection of the best engineers. This appointment is along the right lines for an aggressive company whose reliability depends on the excellence and thoroughness of their inspections.

The British Columbia Electric Railway Company have, by agreement, taken over the branch of the Canadian Pacific Railway known as the Vancouver and Lulu Island Railway and propose to operate it by electric power. A sub-station will be built at Eburne which will supply current for the operation of the road as well as for manufacturing establishments at Eburne, Steveston, and other points. Electric locomotives will be used in the handling of freignt upon various parts of the line. The electrification of the road is expected to be completed by July 1st next. It is announced, unofficially, that the British Columbia Electric Railway Company propose to construct a branch line from Victoria to the Gorge.

MOONLIGHT SCHEDULE FOR MARCH.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Mar. 1	6 20	Mar. 2	5 40	11 20
2	6 20	3	5 40	11 20
3	6 20	4	5 40	11 20
4	6 20	5	5 40	11 20
5	6 20	6	5 40	11 20
6	6 20	7	5 40	11 20
7	6 20	8	5 40	11 20
8	6 20	9	5 40	11 20
9	6 20	10	5 30	11 10
10	6 30	11	5 30	11 00
11	6 30	12	5 30	11 00
12	10 30	13	5 30	7 00
14	11 30	14	5 30	6 00
15	0 30	15	5 30	5 00
16	1 20	16	5 30	4 10
17	2 10	17	5 30	3 20
18	2 50	18	5 30	2 40
19	3 30	19	5 30	2 00
20	No Light	20	No Light	
21	" "	21	" "	
22	6 40	22	9 40	3 00
2	6 40	23	11 00	4 20
24	6 40	25	0 10	5 30
25	6 50	26	1 10	6 20
26	6 50	27	2 10	7 20
27	6 50	28	3 00	8 10
28	6 50	29	3 50	9 00
29	6 50	30	4 30	9 40
30	6 50	31	5 00	10 10
31	6 50	Apr. 1	5 00	10 10
		Total............		227 40

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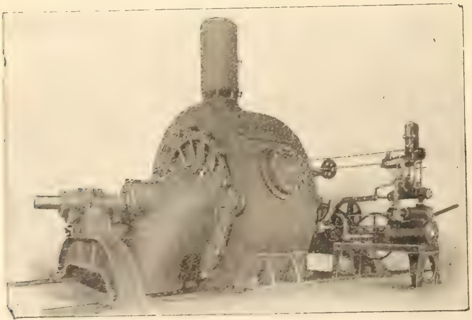

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SEND FOR TABLE OF CONTENTS

SPARKS.

The Canadian General Electric Company have on order a 600 kilowatt generator for the St. John Street Railway Company. It will be connected to a Laurie engine and will be retained as a reserve. The Ottawa Car Company are also building for the St. John Railway six new open cars of modern design.

The York and Toronto Radial Railway Company have extensive plans in contemplation to connect Toronto with outlying points. When the Scarboro line is completed to Highland Creek it will give a ten mile route from the Woodbine to the eastern terminus, and in time this line will be extended to Whitby and Oshawa. The extension from Long Brauch to Oakville, in anticipation of summer traffic, will be undertaken at an early date. The Metropolitan extension to Lake Simcoe is also to be carried out, everything being in readiness to begin work from Newmarket north in the spring.

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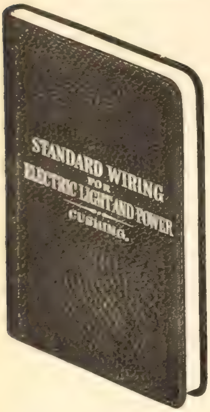

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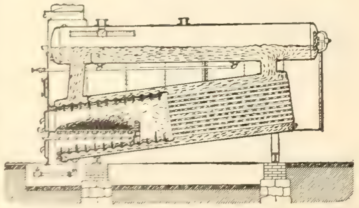

Your coal bill is a large item in your expense account, and if it could be reduced ten per cent. it would mean a large addition to your net profit.

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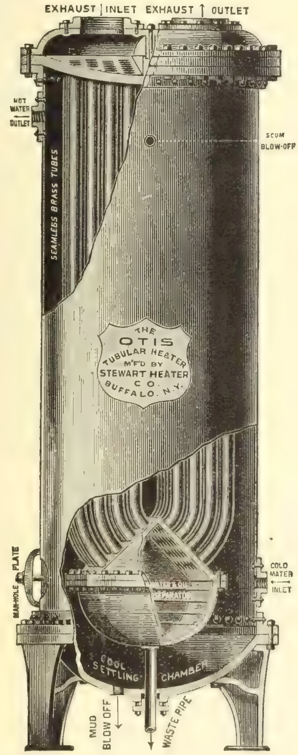

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SPARKS.

The question of installing an electric plant is under consideration by the ratepayers of St. Andrews, N.B.

W. H. Green has purchased the business and plant of the Teeswater Light & Power Company, Teeswater, Ont.

A movement is on foot at New Liskeard, Ont., looking to acquiring a water power and installing an electric plant.

The new electric plant of the Fredericton Gas Light Company, Fredericton, N. B., was operated for the first time about two weeks ago.

The bill to incorporate the Central Canada Railway Company is now before the Manitoba Legislature. This company propose to develop a water power at Lac du Bonnet, on the Winnipeg river, and to build an electric railway from that point to Winnipeg. The capitalization is $6,000,000.

Seaforth, Ont., will not buy the plant of the Seaforth Electric Light and Power Company. The by-law which provided for the payment of $19,000 for the plant was found defective, and the town fathers now consent to judgment in favor of the petition of the ratepayers, Geo. T. Turnbull and Geo. Murdic, setting aside the by-law.

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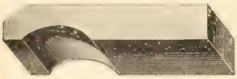

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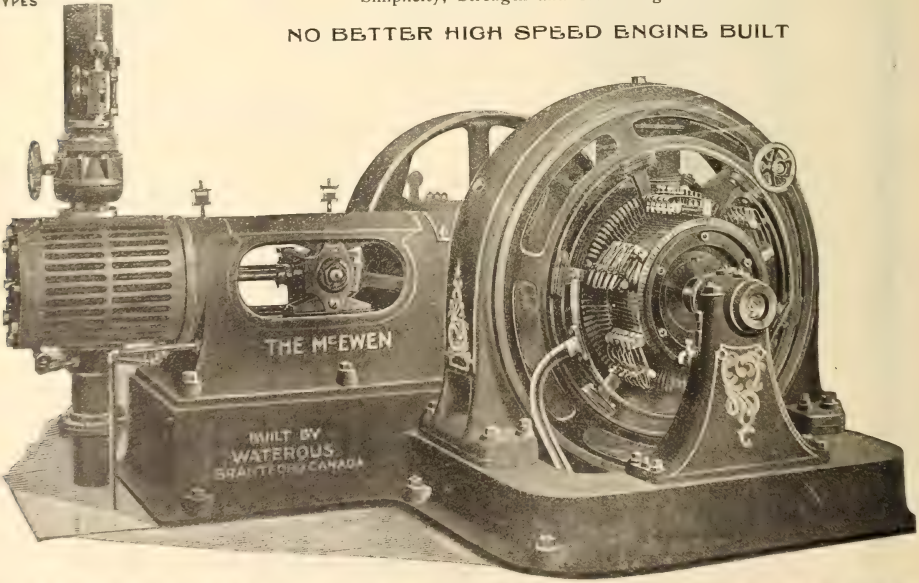

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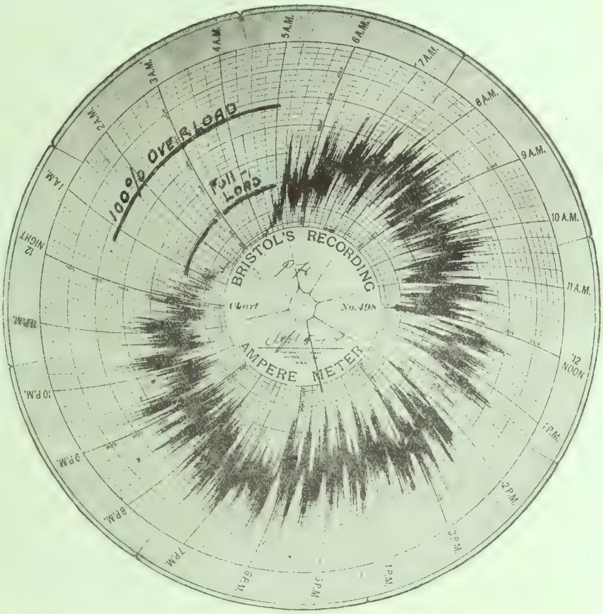
of the

Westinghouse-Parsons Steam Turbine?

A striking answer to this question may be found on the chart shown below taken during regular daily operation from an electric railway plant.

2 : 30 P. M.
A sustained load of over 3100 amperes.

7 : 30 P. M.
A momentary load of 3450 amperes.



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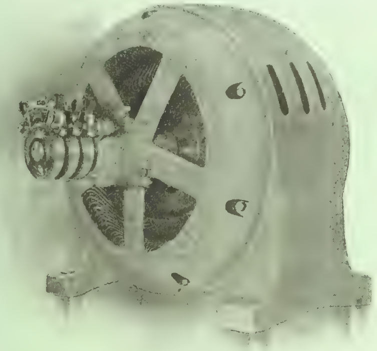

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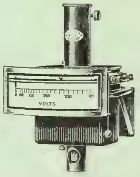

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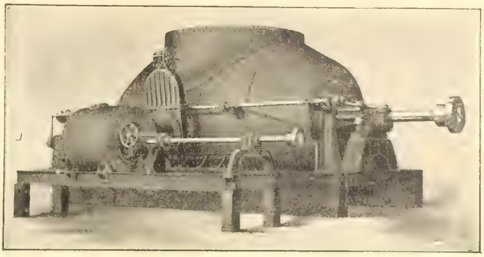

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SPARKS.

The Town Council of Parry Sound, Ont., are considering the enlargement of the electric light plant, at an approximate cost of [illegible].

The City of St. Thomas, Ont., is considering the purchase of a storage battery plant for the operation of the street railway and will likely ask for tenders this month.

The ratepayers of Charlottetown, P.E.I., having voted strongly in favor of a municipal electric light plant, it is probable that steps will be taken immediately towards the installation of a plant.

At a meeting of the creditors of Breck & Halliday, electrical contractors, Kingston, Ont., held on February 22nd, John Geale wass appointed assignee. It is estimated that the liabilities will be $14,000 and the nominal assets $113,000.

The Town Council of Carberry, Man., are negotiating with Mr. Boise, of Portage la Prairie, to establish an electric light plant there. They are willing to grant a ten-year franchise, the corporation to have the option of purchase at the end of that period.

Municipal ownership of electric lighting, though twice defeated by the citizens of Sherbrooke, Que., continues to be an issue in that city. The Council now propose to endeavor to compel the company to sell their plant by arbitration under a certain clause of the original agreement.

Incorporation has been granted to the Ontario & Minnesota Power Company, Limited, with a capital of $3,000,000, the head office to be in Toronto. The charter members are E. W. Backus, Minneapolis, Minn., and A. McKenzie, W. H. W. Templeton, George F. McFarland, and Robert A. Grant, all of Toronto.

The Light and Power Committee of the City Council of Kingston, Ont., have decided to recommend that the rates for light be reduced after July 1st next from $2 to $1.50 a thousand feet for gas and from 14 cents to 12 cents for electricity. At present the city is supplying power to operate the street railway, but the agreement expires this week.

The Blind River Light, Heat & Power Company, Limited, has been incorporated at Blind River, Ont., to construct and operate works for the production and distribution of electricity. The share capital is $40,000 and the directors include Messrs. E. F. Bradley, ot Toronto, and Fred. R. Price and D. S. Pindell, of Sault Ste. Marie, Mich. Mr. Pindell is an electrical engineer.

The town of Napanee will apply to the Ontario Legislature for permission to issue $40,000 of debentures for the installation of an electric light plant. At a recent meeting of the Council, the Napanee Water & Electric Light Company offered to sell their plant to the municipality for $27,000 or to make entensive improvements to the plant provided the town would grant them a loan of $18,000.

It is reported that Montreal and Toronto capitalists, under the leadership of Sir Wm. Van Horne, have formed a company with a capitalization of $50,000,000 to secure control of the different street railway systems of Rio Janeiro, Brazil, as well as the lighting facilities of that city. The company have already secured control of the only water power within a convenient distance of the city.

The project for the development of a water power at Grand Falls, N.B., includes not only the manufacture of ferro-manganese, but also the operation of pulp and saw mills, the transmission of electric power down the St. John River Valley as far as St. John, and the operation of an electric railroad from Campbellton to Edmundston. The expenditure is estimated to exceed $3,000,000, and it is understood that the engineers who have examined the falls have reported that the minimum power is 40,000 h.p. Those financially interested include Barton E. Kingman, of New York, and Frederick Sayles, of Providence, R.I.

The street railway of Kingston, Ont., is about to go into the hands of the bondholders to satisfy a mortgage amounting to about $2,000. One of the cars was recently seized but was released upon one of the directors giving his personal bond. The situation is explained by one of those interested as follows: "Owing to the mix-up with the county, and the fact that the interest was not paid last January, the bondholders appointed a trustee, in the person of Dr. R. V. Rogers, K.C., who will assume control for the present until matters are wound up. The road has not been paying, and hence the interest could not be met. It is understood that there are also many outstanding debts. Hugh C. Nickle, the present superintendent, will be general manager of the road."

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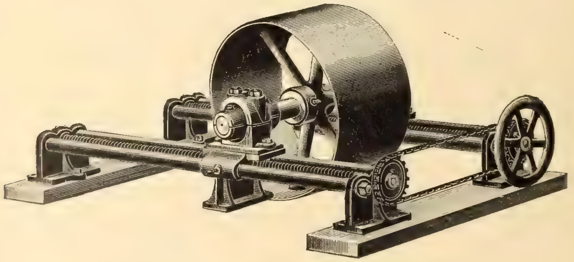

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SPARKS.

The Toronto Railway Company intend building a large number of new cars, some of which will be of new design.

Messrs. W. Moore & Sons, proprietors of the electric light plant at Meaford, Ont., have refused the town's offer of $8,600 for their plant.

Mr. E. Braun, of the British Columbia Electric Railway Company, Vancouver, B.C., has invented a new automatic switch for use on street railways.

The Council of Duncans, B.C., have been asked to submit to the ratepayers a by-law enabling a company to supply that municipality with electric light and water.

The Molson's Bank, a creditor for $23,830, recently asked for the winding up of the Eager & Sanderson Company, flour and feed dealers and owners of an electric light plant at Winchester, Ont.

Mr. W. H. Shillinglaw, City Engineer of Brandon, Man., has been instructed by the City Council to prepare plans and estimates of cost of an electric plant to light the streets and public buildings.

It is announced that Hon. Chas. D. Haines has bought the charter of the Hamilton, Galt and Berlin electric railway and will make application to the Dominion Parliament to permit an extension of the line to Puslinch Lake and Guelph.

A number of tariff changes have been made by Dominion order-in-council. Carbons over six inches in circumference, when for use as materials in Canadian manufactures, have been transferred to the list of goods which may be imported free of duty until otherwise provided.

According to the annual report of the Light Department, the total number of lamps in use in Montreal for street lighting on December 31st last was: Arcs, 1,428; incandescents, 387; and gas, 414, making a total of 2,229 lamps of all descriptions. The report concludes: "A mean average of tests made during the year on the city lamp circuits indicates that the company has satisfactorily complied with the provisions of its contract, which began January 1, 1904, and is to run for five years. The price per lamp is given as follows:—Arc, $60; incandescents of 65 candle-power, $30; and of 32 candle-power, $15. By an understanding between the city and the Montreal Light, Heat & Power Company in 1901 an average price was fixed for the last two years of the old contract, and the first two years of the new contract, and according to this agreement we are still paying $89.92 a year for 1,203 lamps. This agreement will terminate December 31st of this year, and the city will then pay a uniform price of $60 a lamp."

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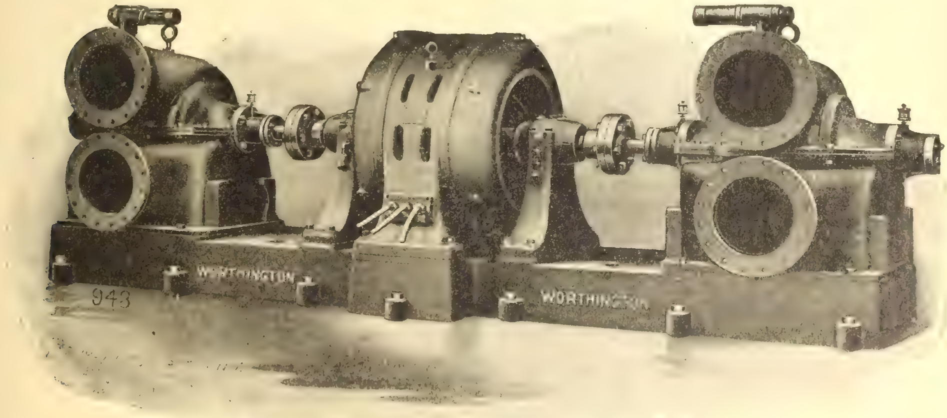

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The John McDougall Caledonian Iron Works Co., Limited, Montreal, Que.

BUILDERS FOR CANADA

SPARKS.

Prince Albert, N.W.T., is installing another dynamo for the municipal lighting plant.

The City Council of Brantford, Ont., have invited independent telephone companies to submit offers for the installation of a telephone system for that city.

The Bell Telephone Company have given an order for a new switchboard for the Winnipeg Exchange. It will have a capacity for ten thousand subscribers.

Mr. T. B. Caldwell, M.P., has submitted to the Town Council of Renfrew, Ont., the terms upon which he will supply Renfrew with electric power from Calabogie, where he owns a water power capable of developing 2,000 h. p.

At a meeting of the Electrical Section of the Canadian Society of Civil Engineers held at 877 Dorchester street, Montreal, on Thursday, March 9th, Mr. John S. Stone read a paper on "Electrical Resonance in Wireless Telegraphy."

The Ontario Government has granted a charter to the Marmora Electric Company, Limited, of Marmora, Ont. It is proposed to acquire the property and plant of the Marmora Electric Company, and the capital stock is placed at $40,000.

Mr. H. F. Strickland, electrical engineer, of Toronto, has just completed the installation of a light and power plant in the new shops of the Goldie & McCulloch Company at Galt, Ont. The plant consists of a 150 k.w. C.G.E. direct connected direct current unit and Bullock motors. It is a model plant in every respect.

The new power house at Regina, N.W.T., built for the town by John Galt, C.E., of Toronto, has been completed. It is about 75 feet square and contains two Babcock & Wilcox water tube steam boilers each of 150 h.p. and a 450 h.p. high duty Corliss engine direct connected to a Westinghouse alternating current generator of 300 k.w. at 150 r.p.m., for supplying light and power.

Mr. Frederic Nicholls, general manager of the Canadian General Electric Company, of Toronto, has presented to the Department of Physics of the University of Manitoba, Winnipeg, a quantity of electrical apparatus, including one 2½ k.w. 125 volt compound-wound generator complete with pulley and rails and field rheostat. The generator will be operated by a three h. p. 500 volt shunt wound motor connected by means of a belt. The controlling instruments will be mounted upon a blue Vermont polished marble panel. It is expected that this installation will be made vse of by science students for testing and other purposes.

Dalton & Eveleigh, architects, of Vancouver, B.C., have prepared plans for the new sub-station to be built near Eburne by the British Columbia Electric Railway Company, for operating the Lulu Island branch. In this station there will be installed the necessary apparatus for reducing the power to the regular working pressure. This building will be 50x50 feet and built entirely of concrete. It is understood that the Canadian General Electric Company have secured the contract for the electrical equipment, as well as for motors for the cars. An English firm will, it is said, supply the necessary wire.

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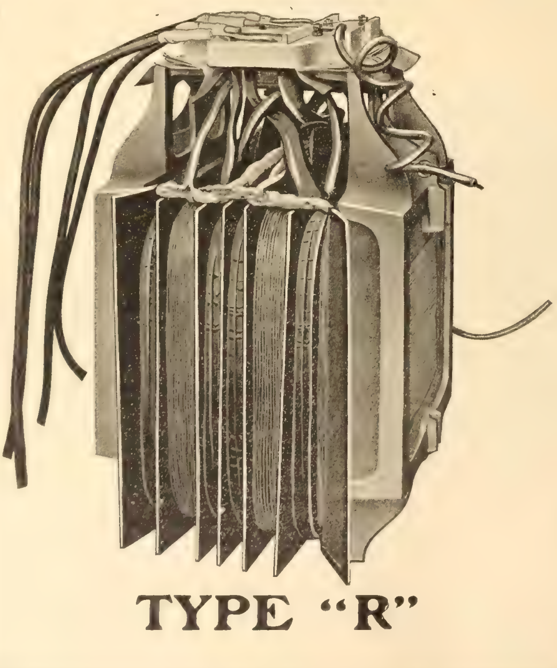

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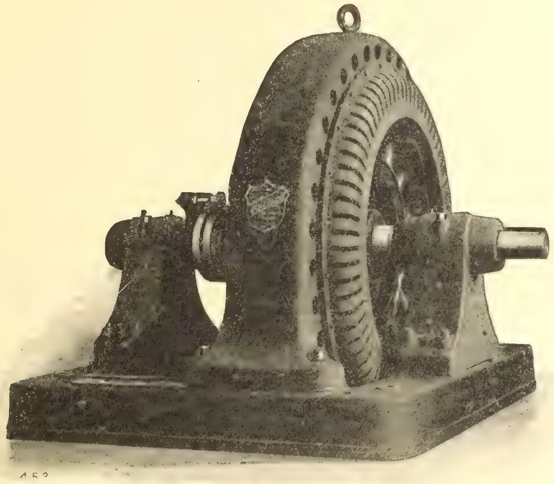

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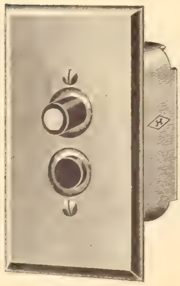
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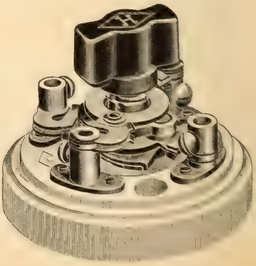

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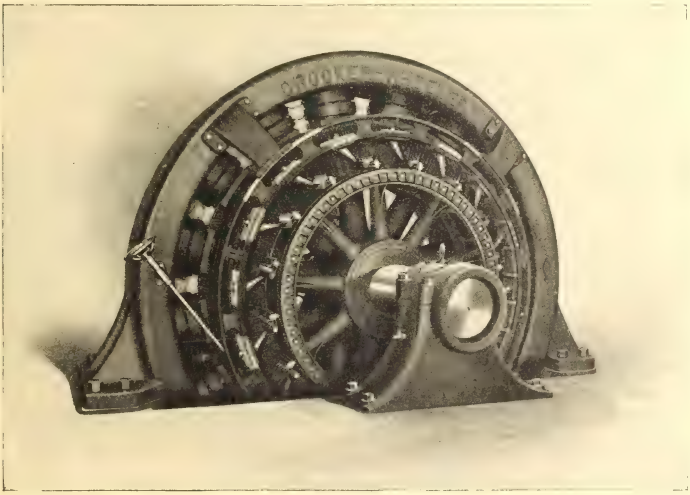

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MONTREAL - - - WINNIPEG

THE CANADIAN ELECTRICAL ASSOCIATION.

At a meeting of the Executive Committee held recently sub-committees were appointed to procure papers and make other necessary arrangements for the Annual Convention to be held in Montreal on June 21st, 22nd and 23rd. Mr. A. A. Dion, of Ottawa, has kindly consented to again become the editor of the Question Box. He is now sending out literature to the members and central station managers throughout the country soliciting questions and answers. In view of the value to every member of the information which Mr. Dion is endeavoring to collect and publish, it is hoped that he will have the active assistance of all persons to whom his requests for information may go.

It is the intention to publish all the questions and answers in book forms as was done last year, but should any enquirer desire an immediate answer Mr. Dion will be pleased to forward same if necessary postage is sent for reply.

Montreal is well known as a center of electrical industry, and has many interesting features such as will repay inspection by the members of the Association and of the electrical fraternity generally. In the line of electrical transmission there are in operation transmission lines of 5,000, 12,000, 22,000 and 50,000 volts.

This last mentioned transmission at 50,000 volts is operated by the Shawinigan Power Company over a line 90 miles in length, being the longest transmission line at that voltage east of the Rocky Mountains. At this company's sub-station in Montreal there has just been installed a 4,000 k. w. generator set which is the largest of its kind in the world.

Apart from these interesting features there are a large number of important isolated plants, and electrical power is very widely used for a great variety of purposes. A strong local committee has been organized to look after the local arrangements, and every effort will be put forth to make this a record meeting.

An effort is being made to obtain papers which should interest and instruct the owners and operators of electric light and power stations, and it will pay this class of men to attend the meeting and take part in the discussions.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

Considerable progress is being made by the committee in charge of arrangements for the next convention of the National Electric Light Association. This convention will be held in Denver and Colorado Springs, Col., during the week of June 5th.

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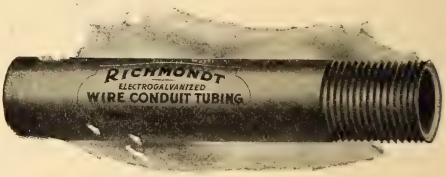

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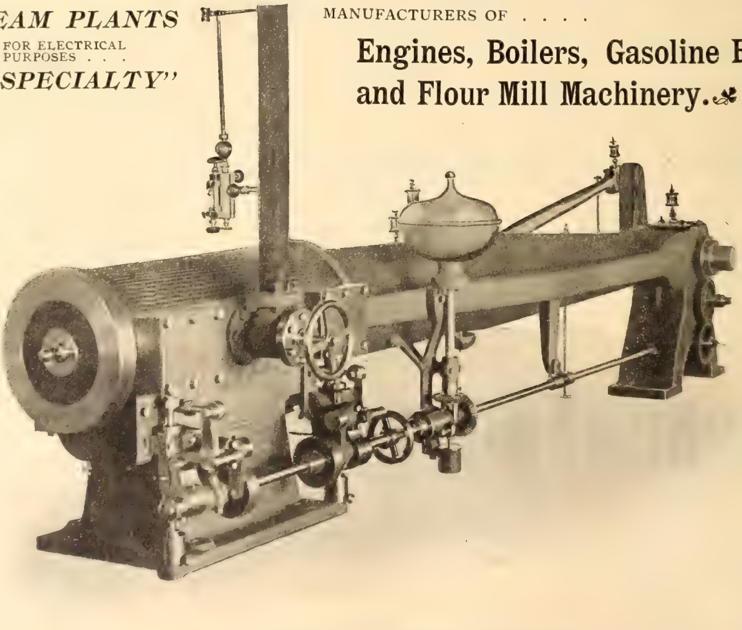

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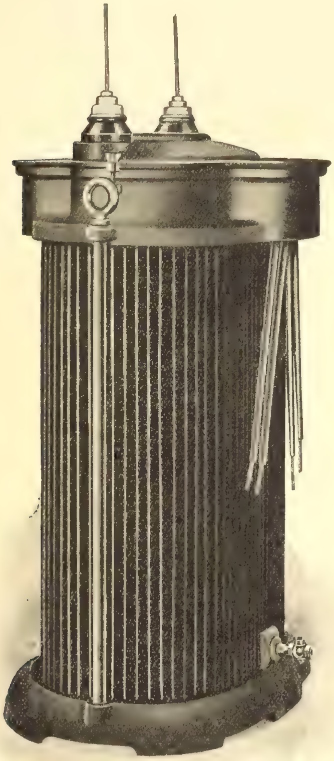

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If you expect to install a transmission or to make extensions, write for prices and information on these transformers.

Pittsburgh Transformer Company
Pittsburgh, Pa.

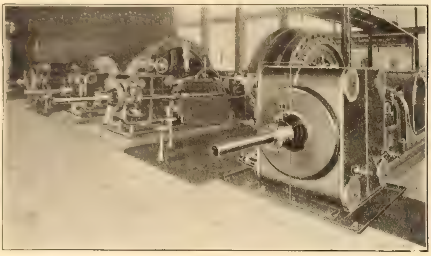
SPARKS.

The Cape Breton Electric Company, Sydney, N. S., have recently installed a large boiler from the works of the Robb Engineering Company, Amherst, N. S.

Mr. F. W. Thorold, city engineer of Calgary, N.W.T., is asking for tenders up to Thursday, March 16th, for the installation of a complete electric light plant. The work is divided into seven sections.

Mr. H. C. Kennedy, of Wiarton, Ont., has secured an option on the famous Lake-of-the-Mountain situated at Glenora, about five miles from Picton. Its attitude and great depth of water should make it a very valuable power, and it is understood that Mr. Kennedy will organize a company to supply electric light and power to the adjacent municipalities.

The annual meeting of the Peterboro Light & Power Company was held during the past month. The reports presented showed increased business and satisfactory earnings. The company are now supplying about 50 arc lamps to private concerns. The following officers were elected: President, T. E. Bradburn; vice-president, John Stuart, Chicago; secretary-treasurer, Robert Gordon, Chicago. J. H. Larmonth was reappointed manager



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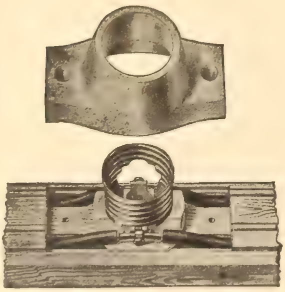
Fielding Moulding Receptacles

Pat. August 25th, 1903.



The " NEW IDEA" in Receptacle is made in two pieces, cap and base in one, center another.

The center is the receptacle complete and rests on top of moulding, when in place is entirely covered by cap, which " fits square" with capping.

The "NEW IDEA" receptacle eliminates cutting or tapping the wire, or sawing the moulding. Line connections easily " get-at-able."

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			T. & H. Base,		
Oxidulated	16535	270	Plain	250	.25
Oxidules	16538	271	Shade Holder	250	.30

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PUBLICATIONS.

The Brown & Sharpe Manufacturing Company, of Providence, R.I., have sent us their 1905 catalogue of machinery and tools, which is now ready for distribution.

"Wattmeters, and How to Read Them" is the title of an instructive little booklet issued by the Westinghouse Electric & Manufacturing Company, of Pittsburg.

The Canadian Westinghouse Company, Limited, Hamilton, Ont., have reprinted in phamplet form G. Brewer Griffin's paper on "Points for Consideration when Purchasing Series A.C. Arc Lamps," read before the Ohio Electric Light Association. This company have also issued Circular No. 1096 referring to oil switches and circuit breakers.

The catalogue of the Westinghouse-Parsons steam turbine, published by the Westinghouse Machine Company, of Pittsburg, is artistic as well as instructive. The construction of this turbine is clearly explained by means of illustrations and letterpress, while the tables of tests show the results which can be accomplished by turbines of different sizes and under varying conditions.

Royce, Limited, of Manchester, England, have sent us a copy of the third edition of their catalogue illustrating and describing a variety of types of electrically-driven cranes and other appliances which they have constructed and erected. This firm claim to be pioneers in the particular branch of electrical and mechanical engineering dealing with the adaptation of electrical energy to cranes, hoists, etc. In the catalogue are to be found splendid illustrations of cranes ranging in capacity from 1 to 50 tons. Any of our readers who may be interested in electric cranes should write for a copy.

We have received a copy of an interesting bulletin containing a report made by Mr. Arthur L. Williston, chief of the mechanical department of the Pratt Institute of Technology, Brooklyn, N.Y., covering tests showing the friction of several types of bearings under various conditions, also the starting torque in various bearings under different conditions. We are advised that as the result of the showing of these tests the Cincinnatti Road Rolling Company, at whose suggestion the tests were made, have adopted the Hyatt bearings, which are manufactured by the Hyatt Rolling Bearing Company, of Harrison, N.J.

Bulletin No. 21, issued by the Packard Electric Company, of St. Catharines, Ont., is descriptive of the Jandus series alternating arc light system. The regulating apparatus of this system is of the inductive type and consists of an impedance coil, a laminated iron core and a mechanical device maintaining the two in such relative position that the inductive drop in the coil is inversely proportional to the number of lamps operating on the circuit. On an alternating current circuit of constant potential, it is possible in a properly designed machine automically to maintain a constant impedance in the circuit and therefore to obtain throughout the range from full load to no load a current of constant value. Such is the function of the Jandus regulator. The Packard Company will be pleased to mail a copy of the bulletin describing this system to any reader of the ELECTRICAL NEWS who may be interested.

The 1905 edition of the "Imperial Directory of Electric Lighting and Electric Traction Works" has reached our desk. It is a very large volume edited by C. S. Vesey Brown, M. Inst. C.E., M.I.E.E., of 52 Long Acre, London, W.C. It contains (1) statistics of electric lighting works; (2) statistics of electric traction works; (3) light railways—electric; (4) light railways—steam; (5) light railways—orders awaiting confirmation by Board of Trade; (6) light railways—applications before the Commissioners; (7) tube and standard gauge railways. A section is devoted to the colonies, wherein it is shown that the electric lighting plants in Canada in operation number 317, practically equivalent to those in operation in the United Kingdom. The progress which electric lighting and traction has made in Great Britain and Ireland since 1900 is shown by the following figures of plants in operation: Electric light plants in 1900, 187; in 1904, 326; electric traction works in 1900, 37; in 1904, 166.

The Sarnia Street Railway Company, Sarnia, Ont., are building a frame and concrete pavilion at Lake Huron Park.

The Dominion Government have passed an order-in-council approving of the application of the village of Morrisburg, Ont., for the right to develop 1,100 horse power in the Williamsburg canal. The ratepayers will therefore be asked to authorize the council to borrow $76,100 for electrical development purposes.

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As some of our competitors have circulated the report that an injunction had been obtained restraining the manufacturers of the Gutmann Meter from making these celebrated instruments here, we would say that such is not the case. We have a large stock on hand and a large shipment on the way from our Canadian Factory and can ship all orders immediately upon receipt.

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CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XV. MARCH, 1905 No. 3.

TRANSFORMER THAWING OUTFIT.

BY M. A. SAMMETT,
Of the Montreal Light, Heat and Power Company.

The thawing out of frozen water pipes by means of electricity is a new application which is becoming widespread. Electricity as a thermal agent in this particular use secures best results in the shortest possible time, leaving the pipes intact, making excavations unnecessary and furnishing the cheapest means to restore water supply. While by no means a new method, it is now a necessary adjunct of every electric operating company, and the growing need of transformers with a capacity for heavy currents has forced transformer manufacturers to place on the market special transformers for this purpose.

TRANSFORMER THAWING OUTFIT USED BY THE MONTREAL, LIGHT, HEAT AND POWER COMPANY.

Prior to the special transformers, it was necessary to use apparatus of very large capacity, in order to be able to obtain heavy currents, so frequently 40 k.w. transformers were used with a water rheostat in series with the secondary coils, thus making the outfit very bulky.

The Montreal Light, Heat & Power Company, at the present time, has four transformer thawing outfits, of 10 k. w. capacity (normal) load, similar to the one shown in the accompanying photograph. These are doing most effective work. The transformers are of special design made by the writer, with the object of securing full capacity of the transformer at various voltages. So far, the various transformers designed by the leading manufacturers have as a means of regulation either a reactance in series with the secondary coils, or a magnetic shunt on the core, or taps on the secondary winding. In every case, when using a current at a fractional secondary voltage, the transformer capacity is lessened, since the secondary current is a fixed quantity.

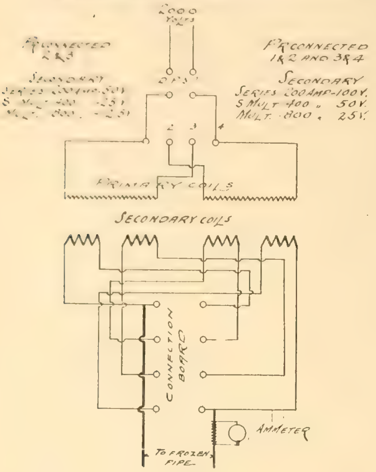
In the case of the transformers of the Montreal Light, Heat & Power Company, above mentioned, there are four secondary coils. The start and finish of every coil are brought out to a connection board, and various combinations of the four coils can be obtained. The three switches engage one at a time with the connection board, and the different combinations are obtained, i.e., four coils in series, coils in series multiple, and all coils in multiple. This arrangement will allow the use of full capacity of the transformer with every combination, so in the case of the four coils in series a current of 200 amperes at 50 volts is secured. With the combination of coils in series multiple, 400 amperes at 25.0 volts are secured, and with all coils connected in multiple, 800 amperes of 12.5 volts are available. The primaries are connected on 2000 volt distributing circuits. As the transformers operate intermittently, in an atmosphere of very low temperature, considerable overloads to an extent of double the load are permissible over a period of one half an hour.

Besides the three combinations on the secondary coils, the transformer is designed so as to allow the placing of the primary coils in multiple and thus enable one to double the secondary voltages for every combination. To secure these results it was necessary to design the transformer with a low magnetic density, keeping the iron at a comparatively low point of saturation. Connecting the primary coils in multiple the following would be the voltages on the secondary side: 100 volts, 50 volts, and 25.0 volts. These voltages give a range wide enough to take in pipes from large mains to small service pipes, and in a number of cases it was found that in the work on service pipes of one-half in. in diameter, and about 200 feet long, the 50 and 25.0 combinations were used with very good results.

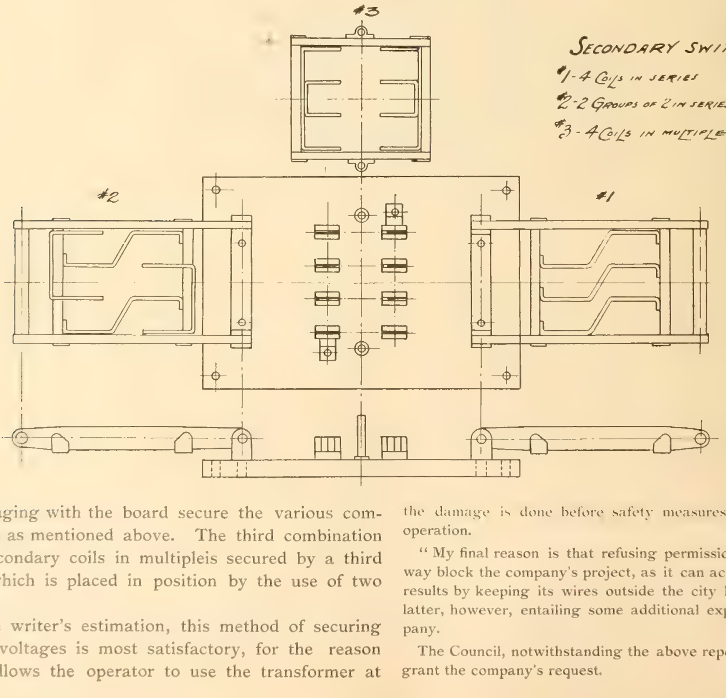
In starting the work on thawing out, a switch of the combination of the 50 volts is used first, and as the current comes up to about 200 amperes, this switch is opened and the switch of the series multiple combination is closed, enabling 400 amperes to be taken off the transformer.

The average time required to thaw out frozen water pipes with this outfit is from two to three minutes, and in one instance a water pipe was thawed out in as little time as fifteen seconds. This commends itself very highly as to the efficiency of electric current in this application.

DIAGRAM OF CONNECTIONS.



The switch used in connection with these transformers as shown in the sketch is composed of a connection board with eight studs to which the secondary coils are connected. The right and left-hand switches engaging with this board are made of heavy copper bars and engaging with the board secure the various combinations as mentioned above. The third combination of all secondary coils in multipleis secured by a third switch which is placed in position by the use of two guides.



In the writer's estimation, this method of securing variable voltages is most satisfactory, for the reason that it allows the operator to use the transformer at full capacity, rendering it suitable for work on small service pipes, as well as pipes of large cross section in heavy mains.

HIGH TENSION WIRES.

There has been a lively discussion in the Vancouver City Council on the question of allowing the British Columbia Electric Railway Company to string their high-tension wires on poles along certain streets so as to operate their Lulu Island branch. The Mayor is opposed to such permission. M. J. A. McCrossan, city electrician, has also reported against the privilege, and in a etter to the Council he gives his reasons, which are as follows:

"The city permitted the company's high-voltage wires to be erected upon two streets in the East End two years ago, in order that the company could bring into the city the current generated by the water power at Lake Beautiful. These high-tension wires run to the transformer station on Westminster avenue, where the current of 20,000 volts is reduced to various lower voltages for safer transmission through the streets of the city. It was not the intention either of the city or the company to introduce a high-tension distributing system in addition to that then erected, and I do not think it advisable to establish a precedent for extensions of this character.

"There is no question but what high-tension wires are safe (except to the Fire Department) so long as they remain in place and are thoroughly insulated as intended; but if they drop or become crossed with other wires, then it all depends upon the conditions of the case as to what damage may result to life or property.

"In the first place, it is unnecessary for me to dilate upon the power to destroy life, and on the other hand, let me suppose a case occurs with the Street Railway system, either through a feeder wire or trolley. The tendency of electrical currents is to get to earth by the shortest route, and paths are already made for it through the street cars, resulting in firing the cars and possibly killing the crew and passengers. On the other supposition of a cross occurring with the lighting system, this current carried into the buildings and grounding on water and gas pipes would ignite all buildings that it passed through.

"Naturally the current would be cut off as quickly as possible upon anything going wrong, but electricity acts so quickly that the damage is done before safety measures can be put into operation.

"My final reason is that refusing permission does not in any way block the company's project, as it can accomplish the same results by keeping its wires outside the city limits entirely, the latter, however, entailing some additional expense to the company.

The Council, notwithstanding the above report, seem likely to grant the company's request.

AFFECT OF LOAD FACTOR ON COST OF POWER.

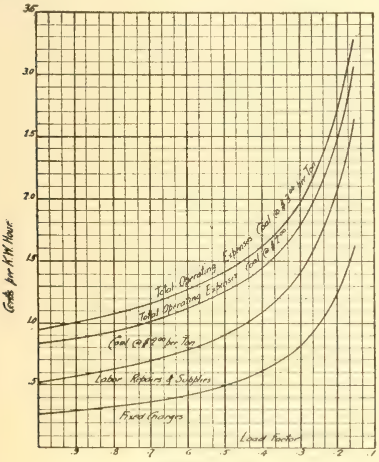
By E. M. Archibald B.Sc.

The great desideratum for an electrical system is a high load factor with consequent greatest return on investment; load factor being the ratio of average to maximum load. All the factors of expense included in cost of power to the consumer are then operating at maximum economy, and cost of power is at a minimum.

The ligthing of residences and offices produces a peak in the ate afternoon and evening, with but little load the remainder of the twenty-four hours; consequently the average load on the plant with lighting only is very small and the load factor low. A commercial motor load in connection with lighting will increase the average load even though causing a greater peak. The addition of a street railway load still further increases the day load, but in consequence of the heavy demand load during the rush hours, when the public is going to and from business, which occurs at the peak of the lighting load, the peak load on the plant is greatly increased. This heavy peak, with but a small average load over the twenty-four hours, produces a low load factor, and a portion of the machinery being shut down the greater part of the time, higher rates must be paid by the consumer to secure a certain return on first investment than when the load factor is higher.

Evidently when the load factor is 100%, that is when the load is constant throughout the twenty-four hours, and all the machinery is in continuous operation, the cost of power per K.W. Hr. is a minimum, and the greatest return on investment is realized. Customers having a steady load or with high average load are greatly desired and may be offered much better rates than all others. It will be the endeavour of this paper to determine the decreased cost of power with increasing load factor.

The storage battery is evidently a means in the hands of the power producing company of increasing the average load on the machinery. By charging the battery during light load and discharging during periods of heavy load, a more constant load on the generating apparatus is produced, with consequent better efficiency, and at the same time acting as a reserve in case of accident in the power plant. Unfortunately the battery is expensive, and a loss occurs in its operation which greatly reduces the higher efficiency secured by the increased load factor. The great benefits obtained by its use are reserve capacity and voltage regulation, enabling the use of more efficient lamps.



Operating Expenses of 900 K.W. Condensing Steam Plant - Peak 750 K.W.

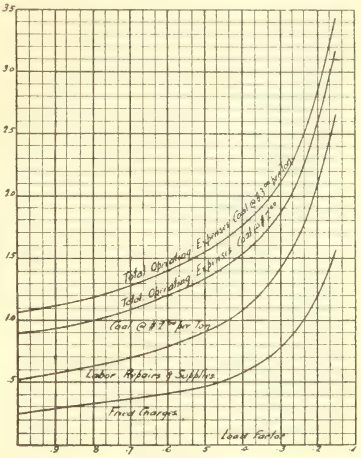
Fig 1

The storage battery, however, has not been considered in what follows, even where it might be desirable, but rather a plant is assumed of certain maximum capacity for the peak load, and we are to determine what effect various load factors have on the cost of power produced.

The various expences involved in the cost of power to the conumer are as follows: (1) management; (2) distribution; (3) production.

For a given system with given peak load the cost of management is practically constant, no matter what the load factor.

The cost of distribution is constant with various load factors in so far as the fixed charges and maintenance is concerned. The losses in distribution, however, vary, these consisting of losses in lines, transformers if alternating current is used, meters, losses in grounds and losses from theft of current; all decrease the output and accordingly increase the cost to the consumer. While it is possible to determine fairly accurately the losses in lines, transformers and meters with varying load factors, the losses from grounds and theft are indeterminate and require constant attention to keep them within certain limits. Yet as a rule these latter will become a smaller percentage of the total output the higher the load factor.



Operating Expenses of 900 K.W. Non Condensing Plant - Peak Load 750 K.W.

Fig - 2

There yet remains for consideration the effect of the load factor on the actual cost of production of energy.

The higher the load factor, the greater is the amount of power produced, the longer does the apparatus operate most efficiently, the lower the ratio of fixed charges to total operating expenses, and consequently the lower the cost of power per unit.

To determine exactly in what proportion the cost of power is decreased, it will be necessary to assume a plant, determine the fixed and variable charges and thereby the cost per K. W. Hr. at various load factors.

Let us take for example a plant with a peak load of 750 K. W. Allow three units of 300 K. W. capacity each, so that in case of a break-down to one, the other two may take care of the peak, with an overload of 25% on each and sufficient boiler capacity for the same contingency. No provision is allowed for stokers, coal handling apparatus or economizers. Plant assumed to be on the water front providing sufficient water for condensing purposes.

Curves are also plotted for a second plant of the same capacity as the first, but operating non-condensing. In both cases either water or railroad connections assumed with convenient facilities for coal handling and removal of ashes.

First cost of plant complete :—

Condensing, $118,425.00 equivalent to $131.60 per K. W.

Non-condensing, $114,625.00 equivalent to $127.40 per K. W.

Fixed charges.	Condensing.	Non-Condensing.
Interest at 5%	$5,921.25	$5,731.25
Taxes and insurance at 2%	2,368.50	2,292.50
Depreciation machinery 10%	7,710.00	7,305.00
Building 3%	1,122.00	1,134.00
Total	$17,121.75	$16,462.75

The above first cost being for 100% load factor, there will be a varying reduction due to the decreased boiler capacity required on lower load factors. A point is reached below where it is not advisable to further decrease the boiler capacity as the peak load must be taken care of and sufficient reserve provided for

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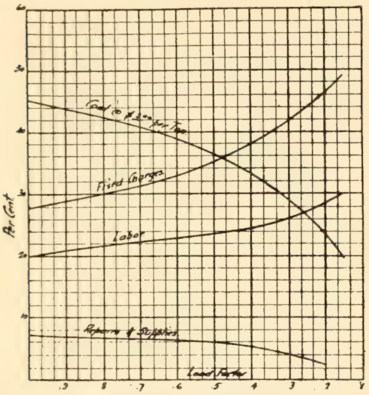
Paper read before the Canadian Society of Civil Engineers, January 25th, 1905.

accidents and repairs ; this point being taken in this case at 40% load factor. The effect of this reduction is to diminish the fixed charges at 40% load factor by $1,000.00 per year, or about 6% of the total. From these figures the lower line in figs. 1 and 2 are plotted and indicate the effect of fixed charges on the cost of power.

The remaining items of expense are what are generally termed operating charges and are variable with load factor. These consist of (1) labor, oil and waste, supplies, water and repairs; (2) fuel.

The cost of labor varies to a certain extent with load factor, but a minimum number of men required to operate the plant is reached at about 40% load factor, below which this item remains constant. The cost of oil and waste, supplies, water and repairs varies almost directly with load factor as the greater number of hours per day that the machinery remains in service, the greater do these expenses become, and vice versa. The second line in figs. 1 and 2 is for these charges reduced to the K. W. Hr. basis and is added to the fixed charges curve ; the difference between the two curves therefore represents the cost of labor, oil and waste, supplies, water and repairs.

The cost of fuel, usually coal, per unit of power generated, varies with some power of the load factor less than one depending upon the number and efficiency of units employed both in the engine and boiler rooms, also upon the cost per ton of coal, its heating value, and upon the ability of the firemen to get the best results ; it is of the utmost importance to watch this item carefully, as greater economy can be secured in the cost of coal per K. W. Hr. than in any other item of expense. The calorific value of the coal should be tested from time to time and compared with the number of lbs. used per K. W. Hr.



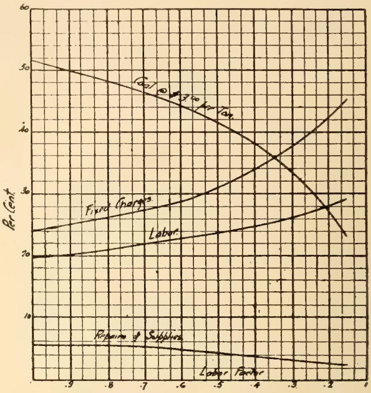
Ratio of Individual Items of Operating Expenses to Total Operating Expenses
900 K.W. Condensing Steam Plant - Peak 750 K.W.
Fig 3

The coal considered is assumed to contain 12,000 B.T.U.'s per lb., and two curves are plotted in figures 1 and 2 when the cost is $2.00 and $3.00 per ton respectively, the results being added to the two previous curves plotted. These figures of fuel cost per K.W.Hr. are above the average usually obtained and can only be secured by constant attention in the boiler room ; for instance at 40% load factor in the first case 1 K.W.Hr. is generated from 3.5 lbs. of coal from the pile.

The ratio of the individual items of expense to total operating expense is shown by figs. 3 and 4 for the condensing and non-condensing plants respectively with coal at $3.00 per ton delivered. It is interesting in this connection to note the high percentage of fuel cost ; in the average plant this percentage will be still higher than that shown, but this indicates how great a factor is the cost of fuel particularly with high load factors. For low load factor the fuel is subordinated by the fixed charges, which is by far the heaviest item.

Having thus determined the cost of power for a plant with a peak of 750 K.W., we shall consider briefly a larger plant and ascertain what extra economies may be secured. This plant we shall assume to have a peak load of 1,500 K.W. and a maximum capacity of 1,800 K.W., divided into three units of 600 K.W. each. Stokers are used, but no economizers or coal handling apparatus ; the boilers are in a single line parallel to the engine room, and coal is dumped from the car into a chute, whence it falls to the floor of the boiler room.

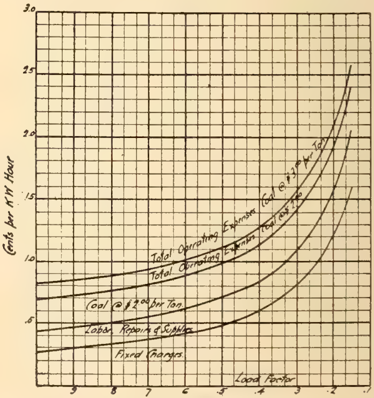
First cost of this plant at 100% load factor is $241,125.00, equivalent to $134.00 per K.W. Fixed charges, using the same per cent. for interest, depreciation, taxes and insurance as in the previous case become $36,318.75 per year. Curves are plotted in fig. 5 for fixed charges, labor, supplies and repairs, and fuel, the latter being plotted for the two prices $2.00 and $3.00 per ton as before.



Ratio of Individual Items of Operating Expenses to Total. Operating Expenses.
900 K.W. Non-Condensing Steam Plant - Peak 750 K.W.
Fig-4

With all these curves before us it might be well to make some deductions as to the advisability of further expenditures in the power plant in coal handling apparatus and economizers, or in general, any apparatus that tends to increase the economy.

The higher the load factor the greater becomes the ratio of variable to fixed charges, and extra investment is advisable to secure the greatest economy possible. Extra investment in coal handling apparatus and economizers will reduce the cost of labor and fuel in greater proportion than fixed charges are increased ; the economizers also provides greater boiler capacity and purer feed water, reducing cost of repairs.



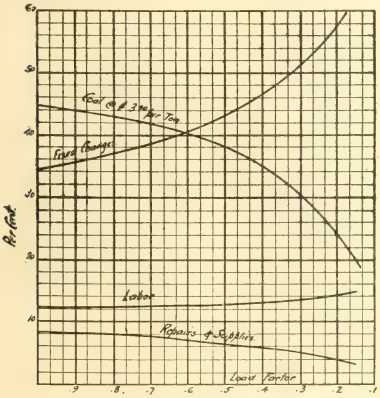
Operating Expenses of 1800 K.W. Condensing Steam Plant - Peak 1500 K.W.
Fig. 5

On the contrary when the load factor on a system is low, the fixed charges are the governing factor in the cost of power, and extra expenditures must be carefully considered, particularly so if fuel is cheap.

Having thus discussed the effect of load factor on the cost of producing power, we shall next turn to the cost of management and distribution. While it is beyond the scope of this paper to fully consider these costs, yet it was thought advisable to indicate by a curve including all the various costs approximately, how the load factor influences the cost to the consumer. This is done very generally, as no two cases are alike ; the cost of distribution is more variable with different systems than is the cost of power, depending on the conditions of distribution, conduit or pole line construction and the extent and density of the territory to be covered.

We shall allow that $50,000.00 per year covers all fixed charges, maintenance and attendance on the distributing net work ; $35,000.00 per year for management, dividends on stock and miscellaneous expenses. For total losses 30% of the output is allowed ; this is taken constant for all load factors, for while the percentage of known losses varies directly with load factor, the percentage of indeterminate losses by grounds and theft varies inversely as the load factor. The actual losses from grounds are constant, hence percentage loss by grounds varies inversely as load factor ; losses from theft usually occur with customers having a short hour load, and the greater the amount of such load connected, the greater this loss. A customer having a long hour load runs a greater chance of detection than others. Hence, the above statement holds that the total percentage loss will be constant. Further, this lost power reduces the amount of sales, therefore affecting all the expenses included in cost to customer.

Fig. 7 shows a series of curves plotted for the 1,800 K. W. steam plant, the lower line representing cost of production; the second, cost of distribution ; third, cost of management, and fourth the effect of distribution losses on cost of power, this last being the final cost to consumer.



Ratio of Individual Items of Operating Expense to Total Operating Expense.
1800 KW Condensing Steam Plant - Peak Load 1500 KW.

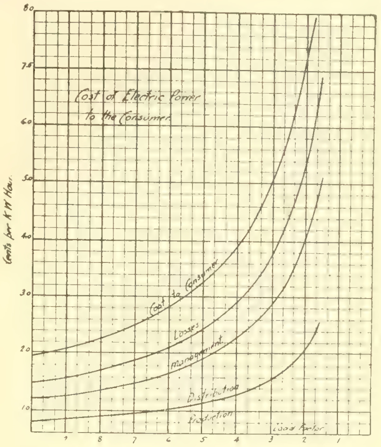
Fig-6

Coal is expensive, and from the nature of things will increase n price, and it behooves us to investigate any method of producing power which is more economical in the use of fuel than the steam engine, and naturally turning to the gas engine we will next proceed to make a comparison between a steam plant and a gas plant generating producer gas for use in gas engines, and from such comparison deduce some general results.

As is well-known, the gas engine has a very much higher thermal efficiency than the steam engine, which fact, together with the fewer number of auxiliaries required, would naturally lead one to suppose that a greater economy could be secured in the production of power.

Difficulties, however, are encountered at the outset in the kind of fuel that may be used successfully in the gas producer. While the gas generated from anthracite coal is very successful in the operation of gas engines, the gas from bituminous coal contains tar which, when carried through the valves into the cylinders of the engine, clogs the valves and carbonizes under the intense heat to which it is subjected in the cylinder, preventing successful operation. Some manufacturers claim to have succeeded in removing the tar or preventing its formation, but the burden of proof still rests with them.

The overload rating of the gas engine is different from the steam engine in the ratio of about 15 to 50 per cent. Hence in designing two plants, steam and gas, for equal overload capacities it is necessary either to use gas engines of 25 to 35 per cent. higher normal rating, with consequent poorer economy at normal load; or add an extra engine and generator sufficient to take care of the extra overload capacity of the steam engine over the gas engine. For example, in designing a gas plant of 900 K. W. capacity with a peak load of 750 K. W., allowing the same reserve as in the steam plant considered previously, three engines of 530 B. H. P. each will be required with an aggregate normal B. H. P. of 1,590 and maximum B. H. P. of 1,830, as compared with three 450 I. H. P. equivalent to 410 B.H.P. engines aggregating 1,230 normal B. H. P. and 1,830 maximum B.H.P. ; or three gas engines of 410 B.H.P. each and an additional engine of 360 B.H.P. aggregating 1,830 B.H.P. on maximum load (from a practical standpoint, this additional engine would be made of the same capacity as the rest, the cost being the same). In the first case at normal load on the generators the engines are 30 under loaded with consequent poor efficiency ; in the second case the first cost will be greater, due to the extra generator and increased size of building required.



Fig·7

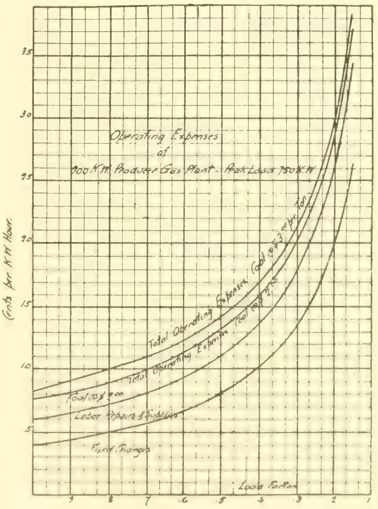


Fig 8

Allowing the same reserve capacity in producers, and with three 530 B.H.P. gas engines direct connected to 300 K. W generators running at 100 r.p.m., the first cost becomes $167,650, equivalent to $180 per K. W.

Fixed charges :

Interest at 5% on $167,650	$8,382.50
Depreciation on machinery 10%	13,340.00
Depreciation on buildings 3%	1,005.00
Taxes and Insurance 2%	3,353.00
Total	$26,080.50

The storage capacity at 100% load factor is small, about 20,000 cubic ft., and is provided more for uniformity of gas than for storage. In case of accident to one producer, a second may be under way producing gas inside half an hour. The question of storage is important, particularly at small load factors when storage may be provided for the peak and a constant load maintained on the producers. In a plant of this size where the number of producers actually required is not over two with a third for reserve, it is more advisable to use the same number of producers for all load factors and a small amount of storage for uniformity of gas and sudden peaks. Further, the extra storage capacity required for small load factors costs about the same as an extra producer.

The operating costs for oil, water, repairs, supplies and water have been taken practically the same as for steam, as there is insufficient reliable data at hand on this subject at the present time.

Cost of labor is somewhat cheaper—for the type of producers considered only one man is actually required.

In fig. 8 are given curves for cost of power with varying load factor for this 900 K.W. gas plant.

A comparison of fig. 1, 2, and 8 shows a greater economy for the gas plant at the higher load factors, but poorer economy at low load factors due to the influence of the heavy fixed charges.

The higher the cost of coal the greater is the economy of the gas over the steam plant at high load factors.

It must be remembered that the fuel economy in the case of the steam plants is taken considerably higher than the average and can only be secured by constant and careful attention to all the details around a power plant ; in the gas plant the fuel at 50% load factor is taken at 1.4 lbs. coal per B.H.P.Hour, which is somewhat higher than the manufacturers will guarantee. No matter how the fuel costs may vary from those given in these curves, they are relatively of far greater importance when the load factor is high than when it is low.

FEDERAL COURT SUSTAINS TESLA PATENTS IN SYNCHRONOUS MOTOR SUIT.

In pursuance of a decision handed down by him on February 20th, in the United States Circuit Court for the Eastern District of Wisconsin sustaining the contention of the Westinghouse Electric & Manufacturing Company that the synchronous motors of the National Electric Company were an infringement of the broad rights covered in Tesla patents Nos. 381968-381969-382280 and 382281, Judge Seaman, in Milwaukee on February 24, enjoined the National Company from the further sale of such motors. The decision in the suit is the first that has been obtained in the litigation begun some time ago by the Westinghouse Company to prevent the sale of synchronous motors and rotary converters by American manufacturers not enjoying a license under the Tesla polyphase motor patents. The hearing in the suit against the National Electric Company was conducted before Judge Seaman on February 6th and 7th, Mr. Thomas B. Kerr and Mr. Parker W. Page appearing for the Westinghouse Company. A decision is now pending in the United States Circuit Court for the southern district of Ohio in the suit brought by the Westinghouse Company against the Bullock Electric Manufacturing Company, alleging similar infringement of the same patent rights in the sale of Bullock synchronous motors and rotary converters. The final hearing in the latter suit was conducted before Judge Thompson in Cincinnati on February 7th and 8th, Mr. Frederic H. Betts and Mr. Page appearing for the complainant.

The Tesla patents involved in these suits have been the subject of considerable litigation in the past few years. The action instituted by the Westinghouse Company a number of years ago against the Thomson-Houston Company, for alleged infringement of the Tesla patents, was discontinued upon the execution of a patent agreement under which the General Electric Company has for several years manufactured and sold induction and synchronous motors and rotary converters. A number of manufacturers have been enjoined from manufacturing induction motors, but the decision in the suit against the National Electric Company is the first court ruling that the synchronous motor is within the generic Tesla invention.

THE ONTARIO MUNICIPAL POWER COMMISSION.

The Municipal Power Works Act of 1903 conferred upon municipalities in Ontario the right to engage in the development and sale at cost price of electric power. The municipalities of Toronto, London, Guelph, Woodstock, Brantford, Stratford and Ingersoll have taken advantage of the power conferred upon them by the Act and have appointed a Commission to report upon the best mode of development and transmission and of the cost of the same, the object in view evidently being the utilization of Niagara power. The Commissioners have appointed Messrs. Ross & Holgate, electrical and hydraulic engineers, to carry out the field engineering work. Mr. R. A. Ross, who was a member of the Commission, has therefore resigned, and Mr. Reginald Aubrey Fessenden, who is at present resident in Washington, D.C., has been appointed to the Commission as consulting electrical engineer.

Mr. R. A. Fessenden, E.E.
Member of the Ontario Municipal Power Commission.

Mr. Fessenden, whose portrait appears herewith, was born in Milton, P.Q., October 6, 1866. He was educated at Trinity College School, Port Hope, and in 1886 and 1887 was inspecting engineer for the Edison Company of New York, and for the following three years was head chemist in the laboratory of Thomas A. Edison. From 1890 to 1892 he was employed at Newark, N.J., as electrician for the Westinghouse Electric & Manufacturing Company, and in 1892-3 was professor of physics and electrical engineering in Purdue University. From 1893 to 1900 he was professor of electrical engineering at the University of Pennsylvania. Recently he has been engaged as a consulting electrical engineer in Washington.

Mr. Fessenden is the author of many valuable articles relating to the science of electricity. Of these we might mention a paper on "Conduction and Insulation" read before the American Institute of Electrical Engineers in 1898 ; "Electro-Magnetic Mechanism with Special Reference to High Speed Telegraphy," Franklin Institute, 1899 ; "Wireless Telegraphy," American Institute of Electrical Engineers, 1899 ; and "Nature of Inertia and Nature and Velocity of Gravitation," Electrical World & Science, 1900, also about sixty other papers.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

QUES. No. 1.—In a water wheel catalogue that I have, the power of a thirty-nine inch wheel is given as 102 horse-power with a ten foot head. With a head of twenty feet, the power of the same size wheel is 290. How is it that when you double the head you get about three times the horse-power? What is the exact relation and how is it got at? Also I notice that with ten feet head, the speed of the 39″ wheel is 138 revolutions, and with twenty feet it is 195. In the first case the wheel uses 6,679 cubic feet of water per minute, and in the last case 9,450. What is the relation between the two speeds, and the amount of water?

ANS.—For simplicity, we will take up the latter questions first. When water is being discharged through an orifice, say one square inch in area, it leaves that opening, when the head is ten feet, with a speed of 1,521 feet per minute. The amount of water discharged under these conditions will be 10.57 cubic feet per minute. Now, if the head be doubled, or made twenty feet, the velocity will be 2,152 feet per minute, and the discharge 14.95 cubic feet. These figures are theoretical altogether, but in practice they are checked fairly closely. It will be seen that if the head be doubled, or multiplied by two, then both the velocity and the discharge are multiplied by 1.41 or the square root of 2. In a water wheel the peripheral speed will always be somewhat below the theoretical velocity of the water. For instance, for the 39″ wheel, the circumference is approximately 10.2 feet. At 138 revolutions the peripheral speed will be 10.2 × 138 or 1,407 feet per minute with a ten foot head, and for this head, the theoretical velocity of the water as already mentioned is 1,521. Now, if you double the head, you increase the water velocity by 1.41, and hence the speed of the wheel will be increased in the same proportion. 138 × 1.41 is 195. The quantity of water varies in the same way. 6,679 (for ten foot head) × 1.41 is 9,450 (for twenty foot head). In other words, the speed of the wheel, and the water used, vary as the square root of the number by which the head is multiplied. Now to take up the first question. If the 39″ wheel gives 102 horse-power with ten feet head, it will give 204 horse-power with twenty feet head, provided the quantity of water per minute is the same with each case. But with the increased head the water used will increase by 1.41, as previously shown. Therefore, to find the power which the wheel will give with twenty feet—102 h.p. × 2 (for the doubled head) × 1.41 (for the increased water) equals 290. Expressed simply, the power of a wheel increases as the square root of the cube of the number by which the head is multiplied. For example—when the head is changed from ten to twenty feet, it is multiplied by 2. The cube of 2 is 8. The square root of 8 is 2.83. Therefore 102 (horse-power for ten feet) × 2.83 equals 290 (horse-power for twenty feet).

QUES. No. 2.—What changes would be required to make a standard 6 ampere 104 volt alternating current enclosed arc lamp operate (a) without an inner globe; (b) in a horizontal position; (c) what number of hours would one pair of carbons last without the inner globe; (d) what is the temperature in °C of the arc of such a lamp; (e) what would be the temperature (approximate) say one-eighth inch from the carbons, parallel with the arc; (f) could an electric arc blow-pipe be used on such a lamp with a view of using the arc for a high temperature?

ANS.—(a) Practically no change in the lamp mechanism itself. Possibly the connecting wire to the lifting magnet might have to be shifted to one of the other taps, and the arc voltage changed by means of the compensating coil, but if any readjustment be required at all it will not amount to much. (b) In order that the lamp be automatic the friction of the moving parts must be very low. In a vertical or normal position, this friction is small, and does not interfere with the operation of the parts, but if the lamp were placed horizontal, a considerable amount of friction would be introduced. It is doubtful if this could be sufficiently eliminated in a standard lamp so as to make the movements smooth and gradual. When the lamp is vertical the pull of the solenoid has to overcome the force of gravity which acts on all the moving parts. With the lamp horizontal the gravity element would be done away with, and therefore some means would have to be provided to produce a pull of the same magnitude towards the base of the lamp. (c) Somewhere about ten hours with a twelve inch trim. (d) Authorities differ as to the exact temperature of the arc, etc. For a direct current lamp the positive would be about 3500°C, based on given averages, and the negative 2500°C. For the alternating lamp the temperatures would be about the same for both carbons, probably an average of the two just given. The temperature of the arc itself will be lower than that of the craters. We presume that it will be somewhere about 2,000°C to 2,500°C. (e) One-eighth inch away from the arc the temperature will be about one-half of that of the arc itself. When dealing with such great heats, it is very difficult to get correct figures. The arc is constantly moving and is therefore very hard to measure. (f) When even a feeble current of air is projected against an arc, the arc is immediately blown out. We are therefore of the opinion that you cannot make use of it for a blow-pipe. In a certain "arc welder" the carbons are brought together at a sharp angle, and a small electro magnet is placed close to their points. This magnet bends the arc outward to a small extent, making it possible to apply it direct to any object. Such a scheme as this would probably answer the purpose of an "arc blow-pipe."

QUES. No. 3.—How much does water weigh, and how is the horse-power of a water fall calculated?

ANS.—The weight of one cubic foot of water is approximately 62 lbs. To get the horse-power, the quantity of water in cubic feet per minute which passes over the fall must be ascertained. This can be found by various methods. The cross sectional area of the stream, times the speed of the water at the centre of the top, times the constant .85, is probably the simplest formula. Then cubic feet, times weight of one cubic foot, times the height of the fall, will give the foot-pounds. This divided by 33,000, the number of foot-pounds in one horse-power, will give the theoretical horse-power of the fall. About 70% of this amount can be converted into mechanical motion, the balance 30% being lost in the wheel, the head race, and the tail race. The formula is simplified as follows:—.00132 x Q x H equals H. P. which can be obtained; Q being cubic feet per minute, and H the head in feet.

SNOW CLEARING IN OTTAWA.

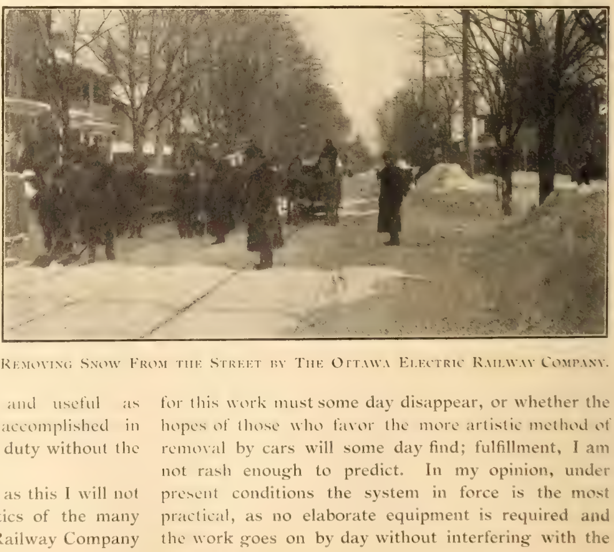
By J. E. Hutcheson,

Superintendent Ottawa Electric Railway Company.

Fifteen years ago it was generally considered impossible to operate an electric railway in Eastern Canada because of the snow problem, and when the subject of a service in Ottawa was first mooted many capitalists refused to risk their money in a project which presented to them such insuperable difficulties. The promoters themselves were not over sanguine and had a clause embodied in the agreement with the City which provided for the substitution of sleighs drawn by horses for electrically propelled cars.

Albert Street, Ottawa, Looking West, After the Storm of January 8th.

When I was drafted from the Canadian Pacific Railway in 1891 and placed in charge of the construction, and later, the operation of this, the first electric street railway in Canada, I must confess I had some misgivings as regards winter operation. Fortunately the devices and methods employed proved successful, and after two or three years, the period of transition, these were improved upon, and have since been adopted and made standard in all cities in Canada. Few people, however, outside of those in the business, realize how formidable is the task of keeping street railway tracks clear of snow, let alone that of disposing of it after it is removed from the rails. Even to those of us familiar with winter railway operation in this part of Canada, the results accomplished are surprising.



Removing Snow From the Street by The Ottawa Electric Railway Company.

The layman asks, "How have the winter battles of the past fourteen years been fought and won?" My answer is, had parsimony been the policy of the directors, or had intelligence, loyalty and co-operation been wanting in our employees, failure might easily have taken the place of success. Marvellous and useful as are the inventions, little can be accomplished in successfully performing a great public duty without the co-operation of officers and men.

Within the limits of such an article as this I will not attempt to describe the characteristics of the many devices used by the Ottawa Electric Railway Company in snow clearing, and will do no more than enumerate.

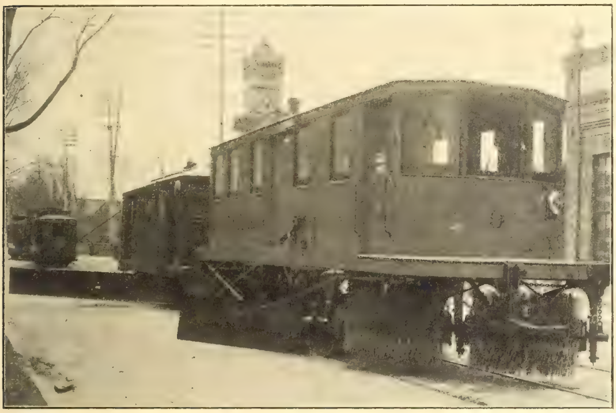
For the information of the reader who may not be familiar with our system, I may say that in winter months we operate cars on eighteen miles of city streets, or thirty-six miles of single track. According to our agreement with the City of Ottawa we are obliged to remove all snow from the streets upon which we operate, including that thrown from the sidewalks and what slides from the buildings onto the streets, leaving what the City Engineer decides is sufficient for sleighing. This he has determined to be six inches.

The snow clearing equipment consists of ten rotary broom sweepers, three electric wing-ploughs, fifteen horse wing-ploughs on wheels, and one hundred snow boxes 12′ × 4′ × 4′. Many cars are equipped with track scrapers and steel wire track brushes.

The sweepers were manufactured by The McGuire-Cummings Manufacturing Company of Chicago and by The Ottawa Car Company, Limited, Ottawa, Ontario. The electric wing-ploughs were designed by the writer and constructed in the shops of the Company, and since they were first put in service two years ago it has not been necessary to use the horse ploughs, so that all the snow clearing is done by electrical machinery, and the removal from the streets by horses. This latter practice, apart from the difficulties we have had in controlling an irresponsible lot of teamsters, works very satisfactorily. A scheme for the removal of snow by large dump cars hauled on the tracks by an electric motor has been given a great deal of consideration. Such a method may be feasible, but many difficulties must be overcome before it can be successfully carried on. Whether or not the horse and sleigh for this work must some day disappear, or whether the hopes of those who favor the more artistic method of removal by cars will some day find fulfillment, I am not rash enough to predict. In my opinion, under present conditions the system in force is the most practical, as no elaborate equipment is required and the work goes on by day without interfering with the car service.

In the early history of the Company the winters were comparatively moderate, consequently heavy snow falls were easily handled. Conditions have changed, however, and the winters of the past few years have been very severe, the heavy snow falls being accompanied by intense cold weather and high winds. The winter of 1903-04 was a terror, the worst ever experienced in this section of the country (the "Oldest Inhabitant" is authority for this statement), the snow fall amounting to 109.75 inches.

Notwithstanding the severity of the winter we were able to operate all our lines daily without serious disorganization.



Snow Sweeper and Electric Wing-Plow Used by The Ottawa Electric Railway Company.

In this district east winds in winter are always a warning of a heavy snow fall, and we have learned that the only way to fight such storms successfully is to start the full battery of sweepers out the moment the snow begins to fall, each sweeper having its own route, the men in charge being the oldest and most experienced in the service. After the sweepers have been at work a short time the three large wing-ploughs are sent out and remove the loose snow back to the curb, piling it up ready to be drawn away. The wings of the ploughs are operated by a competent man inside the cab, and will clear the snow back for a distance of eleven feet from the rail. As soon as this work is completed the work of removing the snow from the streets begins, the business section receiving first attention. The one hundred teams are divided into three gangs, a central, western, and eastern, and the snow is carted to several convenient dumps. The Company supplies only the boxes and men to load and unload. The contractors own the horses and sleighs (bobs) and receive twenty cents per load of, approximately, eight cubic yards.

The superficial area of the streets from which snow has to be removed is 526,271 square yards.

During the winter of 1903-04, 312,000 cubic yards of snow were hauled.

The actual cost of sweeping, ploughing, loading, unloading, etc., is $21,700, .8558 cents per car mile, approximately seven cents per cubic yard, or $600 per mile of single track. This item alone makes up about 10 per cent. of the total operating expenses for the year. The present winter, 1904-05, bids fair to equal, if not surpass, in severity and expense that of 1903-04. The storm of January 7-8, when twenty-four inches of snow fell, came with unusual violence, the wind blowing forty miles per hour with the temperature 10° below zero. The cost of clearing up after this storm amounted to nearly $12,000, and the total expenditure for the winter to date has reached $16,000.

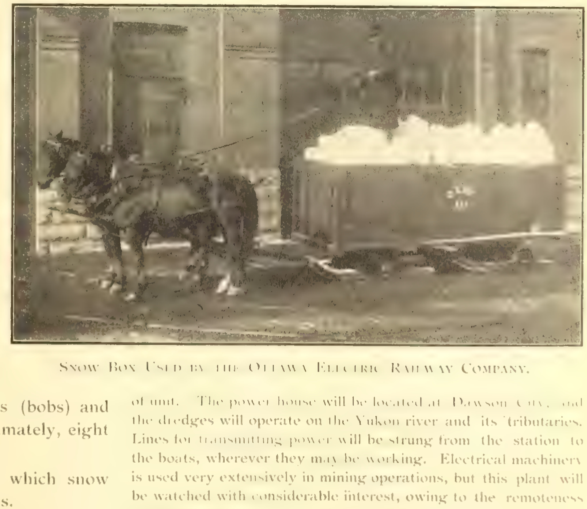
Ottawa, Feb. 20th, 1905.

STEAM TURBINE PLANT IN KLONDIKE.

The Canadian Westinghouse Company, Limited, Hamilton, Ont., have just entered an order for the equipment of a power house for the electrical operation of gold dredging boats on the Alaskan rivers. The plan is an entirely new one and involves many interesting features.

A number of Detroit capitalists recently formed the Canadian Klondike Mining Company. A visit was made to the works of the Westinghouse interests at East Pittsburg to ascertain if electrical machinerv could be used in the gold mining plant. After considering various plans, it was decided to install a 400 kilowatt turbo-generator in the power house, to be driven by a 600 horse-power Westinghouse-Parsons steam turbine. The dredge boats are being built by the Marion Steam Shovel Company, of Marion, Ohio. On these boats will be installed induction motors aggregating a total of about 500 horse-power, and varying in size frnm 7½ to 100 horse-power.

The fact that these people are willing to install a plant of this nature in such a distant country, far from the manufactory and possible repairs, show the confidence engineers place in this type of unit. The power house will be located at Dawson City, and the dredges will operate on the Yukon river and its tributaries. Lines for transmitting power will be strung from the station to the boats, wherever they may be working. Electrical machinery is used very extensively in mining operations, but this plant will be watched with considerable interest, owing to the remoteness of the country and the new field which will be opened.



Snow Box Used by the Ottawa Electric Railway Company.

Mr. James Galloway has finally transferred his electric light plant at Thamesville, Ont., to the corporation.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope o this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

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Niagara Power and Toronto

The starting of one of the large generators in the power house of the Canadian Niagara Power Company on the second day of the new year, marks an important epoch in the production of electrical energy in Canada. This is the first power house to be put in operation on our side of the Falls, and it is not only possible but also probable that before we bid good-bye to the present year the two other power plants will be producing current. So far as the City of Toronto is concerned, Niagara power will be delivered there just as soon as the transmission line is completed. Work on this structure is now being hurried with all possible speed, and the engineers hope that the structure will be ready for work within a very few months. For the total of seventy-five miles, perhaps two-thirds of the steel towers are now in place, and when the balance are installed, not many weeks will be required to string the wires. By the time the line is ready, arrangements will have been made in the sub-stations to take care of a considerable quantity of energy, and as the power house of the Electrical Development Company will not have reached completion by that date, arrangements have been made to purchase from the Canadian Niagara Power Company such current as they are in position to supply.

Conversion of Energy.

There came to our office recently a very interesting table showing the amount of heat in one pound of coal, and the percentage of this energy which is lost in the conversion into mechanical motion. In the plant from which the figures are taken, the generators are direct-connected to the engines, and all power delivered from the engine room is in the electrical form. For reconverting it into mechanical motion motors are used, arranged on either the group or individual drive scheme. The table itself we print below:

PERCENTAGE LOSS OF THE ORIGINAL ENERGY IN COAL.

	Per Cent.
Through grate bars	1.00
By radiation from boiler	5.00
In chimney gases	22.00
By radiation from main steam pipes	1.56
By radiation from auxiliary steam pipes	.22
In auxiliary engines exhaust	1.40
By radiation from main engine	2.08
In main engine exhaust	57.31
In engine friction	.56
In electric generator	.36
In electric mains	.85
In transformers	.39
In motors	.73
	93.46

From this we see that of the total energy in the coal, which we can represent by 100, but 6.54% is delivered by the motors in the form of mechanical motion. While we do not know that these particular figures are absolutely accurate, still we have sufficient data on hand to show that they are not very far out. This loss which takes place is really appalling, and in spite of the efforts of the engine builders, it has been possible to modify it but very little. Evidently, then, the economical conversion of the energy of coal does not lie within the scope of the steam engine. In other lines, rapid advances are being made, and already the gas and gasoline engines have established records for themselves. In the engine using the cheapest grade of crude oil another advance has been made, but still this latter machine has a thermal efficiency of but 30 to 35% of the energy of the fuel. What the prime mover will be fifty or one hundred years hence, is impossible to say, but judging from the general trend of the matter at present, it appears likely that something in the line of an internal combustion engine will supersede the steam engine and boiler.

Use of Wattmeters. The question is often asked by the manager of a small power station, "Should I install recording wattmeters ?" To give an intelligent answer requires a very careful study of the local conditions, and in almost any event, the matter should be reduced to a dollars and cents basis. The meter idea is really the only scheme in connection with a steam driven plant, provided the plant is not too small. Where the plant is small, and all the consumers are small, then it is doubtful if any advantage will be gained by the installation of meters. But even if the plant be small, and there are one or two large users of power, it is probable that very satisfactory results will be obtained by putting these large consumers on a meter basis. When we get up to the large steam driven plants, then the almost universal practice is to put all consumers on meter rate. When the energy which drives the generator is water, then the matter assumes a different aspect. In the steam plant, each kilowatt-hour consumed means just so much coal burned. With the water power plant this is not the case, and up to a certain point, it makes no difference to the station how long each consumer burns his lamps. But in the case of either a small steam plant, or a water power plant, supplying current on a flat rate, the meter offers a means of reducing the total load on the generators, which is of great value. If your load gradually climbs up to and over your normal capacity, put in meters, and the load will forthwith drop. Make your rate so that this will not reduce your revenue. Another point is that if you are supplying free lamp renewals—and every plant should—the number of lamps burnt out on a metered service will be considerably lower than if no meters were used. Hence, considering that the customer pays a meter rental which just about compensates for the investment in these instruments, it is usually a satisfactory scheme to install them. But, as we mentioned before, good judgment must be used in dealing with the matter.

The Tantalum Lamp. The year 1905 has already earned for itself a place of distinction in electrical annals, for in it not only has the incandescent lamp, the invention of Mr. Thomas A. Edison, reached its quarter-century mark, but a new invention has been brought out which threatens to drive both the incandescent and arc lamp completely out of the lighting field. In the incandescent lamp we find a typical example of Mr. Edison's work—the invention, when placed upon the market, was as nearly perfect as the brains of that great man could make it, and when Mr. Edison declared that his investigation along any line was complete, then one felt reasonably sure that no improvements or modifications would be made for a long period of time. Such is the case with the incandescent, for the lamp of to-day has the same essential parts as the lamp of twenty-five years ago, and its general appearance has been altered but little. We do not mean to imply that no modifications have been made, for such is not the case, but merely that any changes which have taken place were of a detail nature, and have had practically no effect on the lamp. And now comes a revolution. In this issue we print a very able article by Dr. von Bolton and Dr. Feuerlein, covering their joint invention of the "tantalum lamp." The paper is complete in itself, and while it is not our intention to make lengthy comment in these columns upon the subject, we consider it advisable to call the attention of our readers to the points of greatest value in the matter which is thus placed before them. To the search for a proper material of which to make his filament, Mr. Edison devoted almost his entire time. Every substance which by some possible yet remote chance might have been of use was tried, and in the end pure carbon was adopted as the only satisfactory material. True, it had many bad points, but nevertheless, the fact that it could be raised to a high temperature without melting won for it acceptance. In the new lamp, the difference is entirely in the filament, which is made of tantalum, a metal which will stand hammering and drawing, can be raised to a very high temperature before melting, and resists the attacks of every chemical with the one exception of the all-powerful hydrofluoric acid. Another point in the favor of the new metal, and one which is worthy of being noted, is that it has a high specific resistance compared with other metals. This has been one of the drawbacks in connection with the use of any metallic substance--the resistances are so low that for use on our standard voltages, filaments of great length would have to be employed. As it is, with the tantalum lamp, the filament for a 110-volt circuit has a length of something over two feet. Were the metal a rare or costly one, the carbon would have nothing to fear, but as the matter now stands, tantalum exists in abundance in various parts of the world, and can be both easily and cheaply prepared for lamp use. Carbon has one very bad point, namely, a negative temperature coefficient. This is what causes such a quick burn-out on increased voltage. On the other hand, tantalum, like other metals, is positive, or in other words, the higher the temperature, the higher the resistance. In figure nine of the article will be found the curves showing the relation between the two substances, drawn on a basis of voltage and resistance. Messrs. Siemens & Halske have been the instigators of this research work, and the fact that their chemists have been engaged for over two years, gives some idea of the great perseverance which has been necessary to achieve success.

Ald. Cockburn and the committee of the Winnipeg City Coudcil which was appointed to look into the question of cheap electric power for the city are busy collecting data and hope to be able to present their report at an early date.

Mr. C. H. Rust, city engineer of Toronto, has recommended to the Board of Works that four centrifugal pumps of 5,000,000 gallons capacity each, be installed in the new addition to the main pumping station, two to be operated by electric motors and two by steam turbines.

The Southwestern Traction Company and the City Council of St. Thomas, Ont., have come to an agreement, the city accepting the company's offer for the use of St. Thomas Street Railway lines through the city. The company in return for a 50-year franchise, agree to pay the city $1,200 per year per mile for the first five years, $1,350 for the second, $1,500 for the third, $1,550 for the fourth, and $1,750 for the last five years making twenty-five years in all. They collect no fares in the city, pay the cost of the power and pay one-half of the cost of maintaining the tracks.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

THE TANTALUM LAMP.*

By Doctor W. von Bolton and Dr. O. Feuerlein.

Part. I. By Dr. W. von Bolton.

Whilst the carbon filament incadescent lamp remained for nearly two decades the sole representative of glow lamp manufacture, progress was being quietly made in this art. The firm of Messrs. Siemens & Halske has for many years been working at the solution of the problem of an economical incandescent lamp, and arrived, some time ago, at the fundamental principle that the visible part of the radiation of an incandescent body increases progressively with its temperature. This warrants the postulate that the most economical lamp will be that whose incandescent material will withstand the highest temperature.

Messrs. Siemens & Halske had arrived at this conclusion and charged me several years ago with the task of discovering a material which should have a melting point considerably above the temperature at which incandescent lighting becomes highly economical, so that filaments made of such a material would not melt or disintegrate at that temperature. Whilst our laboratory work, founded upon this idea, was going on, the first two advances in incandescent lighting were made public, one being the "Nernst" and the other the "Osmium" lamp.

There are certain metals the melting points of which are known to be considerably above 2,000°C., and the task resolved itself into finding one which, while fulfilling the above requirement, could be easily worked to form a filament, and not be very rare or difficult to procure. It was early observed that brown vanadium pentoxide, which, according to Berzelius does not conduct electricity, is, as a matter of fact, a conductor even when cold. This observation induced me to try whether venadic acid could not be electrolytically decomposed. In this I succeeded, but the melting point of the vanadium obtained proved too low for the purpose in view. Since the metals niobium and tantalum are members of the vanadium group, niobium having an atomic weight double that of vanadium, while the atomic weight of tantalum is double that of niobum, it was thought that one or both of these metals might prove to have the desired qualities. On experimenting with niobium on the lines adopted for vanadium, it appeared that this metal has a considerably higher melting point than that of vanadium, but not, however, sufficiently high; moreover, some of the niobium filaments which I made had a very strong tendency to break up when heated by the electric current.

Tantalum was tried next. I reduced potassium tantalo-fluoride in the manner prescribed by Berzelius and Rose and found that the finely divided tantalum so produced became fairly coherent on rolling, so that by this treatment metallic strips of it could be made. It was also attempted to work tantalum oxide into the shape of a filament by mixing it with paraffin and to reduce it directly into the form of a metallic thread. In these experiments there was observed for the first time a minute globule of molten tantalum, and this globule was of sufficient toughness to permit hammering and drawing into wire. Following out this observation, tantalum powder was melted in a vacuum, and then it was found that the highly-heated metal parted with the gases it contained. In this manner I produced my first filaments of pure metallic tantalum, which were, however, very small. When these had been used in lamps with promise of good results, an attempt was made to devise a definite process of purification. The potassium tantalo-fluoride was reduced to metallic powder; this powder contains a small proportion of oxide and of hydrogen which is absorbed during the reduction. When the powder was melted in a vacuum the oxide and absorbed gas disappeared, and a reguline metal remained; on carefully remelting this it became so pure that no appreciable impurities could be detected in it.

The chemical properties of this pure tantalum are very remarkable, and some of them are of such a nature as to lead me to suppose that nobody other than myself has ever had metallic tantalum in his hands. When cold, the material strongly resists chemical reagents; it is not attacked by boiling hydrochloric acid, aqua regia, nitric acid or sulphuric acid, and it is also indifferent to alkaline solutions; it is attacked solely by hydrofluoric acid. Following the behaviour of steel, when heated in the air it assumes a yellow tint at about 400° C., and the tint changes to dark blue when the tantalum is exposed for some time to 500°C., or for a shorter time to 600°C. Thin wires of the substance burn with low intensity and without any noticeable flame when ignited. It absorbs hydrogen as well as nitrogen with great avidity, even at a low red heat, and forms with them combinations of a metallic appearance, but rather brittle. It combines with carbon very easily, forming several carbides which, as far as they are at present known, are all of metallic appearance, but also very hard and brittle. The prodcut which Moissan thought to be tantalum was clearly a carbide of this nature or an alloy of a carbide with pure tantalum, for Moissan himself stated that his metal still contained ½ per cent. of carbon. Considering the high atomic weight of tantalum (183) it is obvious that a very small quantity of carbon suffices to carburize a relatively large quantity of tantalum. This view of the constitution of Moissan's product is confirmed by the properties he ascribed to the metal—namely, specific gravity 12.8, great hardness and brittleness. These are not properties of pure tantalum. When in the form of powder, still containing, as previously stated, oxide and hydrogen, the specific gravity of my material is about 14; when purified by fusion and drawn into wire it has a specific gravity of 16.8. It is somewhat darker than platinum, and has a hardness about equal to that of mild steel, but shows greater tensile strength than steel does. It is malleable, although the effect of hammering is relatively small, so that the operation must be rather long and severe to beat the metal into a sheet. It can be rolled, as well as drawn into very fine wire. Its tensile strength as a wire is remarkably high, and amounts to 95 kg. per square millimetre, while the corresponding figure for good steel is 70 kg. to 80 kg., according to Kohlrausch.

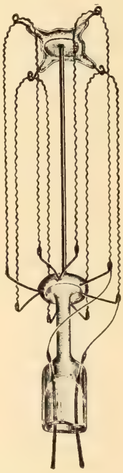
Fig. 1.—Lamp with Corrugated Filament.

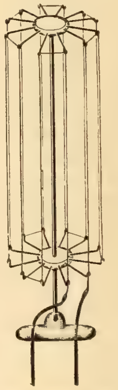
Fig. 2.—Early Type of Tantalum Lamp.

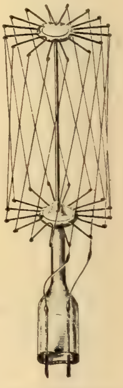
Fig. 3.—Tantalum Lamp with Filaments Fixed Obliquely.

The electrical resistance of the material at indoor temperature is 0.165 ohms for a length of 1 metre and a section of 1 sq. mm. (specific conductivity as compared with mercury 6.06). The temperature coefficient is positive, and has a value of 0.30 between 0°C. and 100°C. At the temperature assumed by the incandescent filament in the lamp at 1.5 watts per candle-power, the resistance rises to 0.830 ohms for a length of 1 metre and a section of 1 sq. mm. The coefficient of linear thermal expansion between 0°C. and 60°C. is 0.0000079, according to experiments made by the Imperial Normal-Aichungs Commission. Fusion is preceded by a gradual softening, which appears to extend over a range of temperature of several hundred degrees. The specific heat is 0.0365, so that the atomic heat is 6.64, which is in accord with the law established by Dulong and Petit.

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*Translation of a paper read before the Elektrotechnischer Verein of Berlin on January 17th, 1905.

PART II.—BY DR. O. FEUERLEIN.

The results of the work carried out in our chemical laboratory, as described by Dr. von Bolton in the first part of this paper, were, of course, of the utmost interest to our incandescent lamp manufacturing department. As soon as Dr. Bolton's experiments showed that the originally brittle tantalum could be made ductile enough to draw into wire by the usual methods, and that this wire could be bent and coiled like a thin steel wire, it became possible to test it thoroughly as to its usefulness for incandescent lamps. The first trials with wires of about 0.3 mm. diameter gave most promising results. They confirmed the fact that tantalum has a very high melting point, and that it is but slightly subject to disintegration in a vacuum, even when subjected to a heavy current.

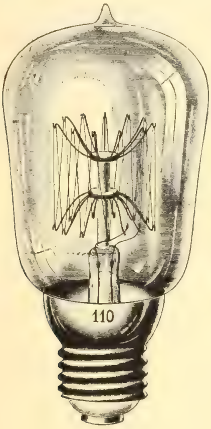


FIG. 4.—COMPLETE LAMP.

The first tantalum lamp that proved moderately satisfactory in that it admitted of an exact measurement of the electric and photo-metric conditions and stood a burning test for some time, was completed just over two years ago—viz., on December 28, 1902. This lamp had a loop-shaped filament made of the first tantalum wire ever drawn. The diameter of the wire was 0.28 mm., its effective lighting length 54 mm. and its electrical resistance when cold 0.29 ohms. This corresponds to a specific resistance (1 metre length, 1 sq. mm. section) of 0.331. The photometric measurements made at efficiencies of 2, 1½ and 1 watt per Hefner candle-power showed potential differences of 4.9, 4.95 and 5.9 volts, currents of 5, 5.49 and 6.2 amperes, and illuminating values of 11, 18 and 37 Hefner candle-power respectively. On being burnt at 1 watt per candle-power the lamp had a life of 20 hours, during which it blackened considerably.

As chemical and mechanical manufacturing processes developed and the material became purer and the wires more uniform, the results obtained also improved. The lamps lasted longer and blackened less; at the same time the specific resistance decreased until it had dropped to the present figure of 0.165 for the pure metal. It is clear that the material used for the first lamps still contained a considerable quantity of impurities, probably niobium and carbides, which caused the great disintegration and the nearly double specific resistance. During these first trials we looked very carefully into the question as to what dimensions the filament of a tantalum lamp ought to have for ordinary voltages and illuminating values. From the dimensions of the filament used in the first lamp we calculated that, with this rather impure material, we should require a filament about 520 mm. long and 0.06 mm. diameter for a lamp for 110 volts, 32 Hefner candle-power and 1.5 watts per candle-power. These unusual figures increased when the specific resistance of the material had diminished to the present value of 0.165, at which for a 32 Hefner candle-power lamp, a filament of about 700mm. in length by 0.55 mm. in diameter was required; for a 25 Hefner candle-power lamp, a filament of about 700 mm. in length by 0.55 mm. in diameter was required. Thus, in order to construct a practical and useful lamp for standard voltages and illuminating values, we had to solve the problem of drawing the tantalum wire in sufficient length down to a diameter of 0.05 mm. to 0.06 mm.; this we succeeded in doing after long and laborious trials.

In July, 1903, we possessed the first tantalum lamp with a filament of about 0.05 mm. diameter. It had a loop-shaped filament 54 mm. long and it took 0.58 amperes at 9 volts and gave 3.5 Hefner candle-power at 1.5 watts per candle-power. On the basis of these figures a lamp having the same quality and diameter of wire and working at the same efficiency on a 110-volt circuit would have a filament 650 mm. long and would give 43 Hefner candle-power. The experiments thus far have proved that the task of producing lamps for 110 volts and a maximum of 25-32 Hefner candle-power was not an easy one in several respects. We had to solve the problem of suitably and reliably fixing a filament rather more than 2 ft. long within a glass globe which should not exceed to any great extent the dimensions of the usual incandescent lamps. The first and most obvious attempt was made, of course, by adhering to the loop shape and accommodating the required length of wire by connecting several such bows in series within the lamp. However, lamps made according to this plan with two to four tantalum loops gave results which were anything but satisfactory.

It appeared that, like all other metallic filaments which have hitherto been used for incandescent lamps, tantalum wire softens sensibly at the temperature attained when worked at 1.5 watts per candle-power. To use loop-shaped or spiral filaments similar to the carbon filaments of the common incandescent lamps, was, therefore, out of the question. There was no difficulty in suspending the loops, but in that case the lamps would have to be used exclusively in a vertical position, a limitation which we wished to avoid in all circumstances. Besides, such a construction would necessitate staying the loops firmly to prevent them from becoming entangled with each other during transport of the lamps. Nor did lamps made with loops of corrugated wire (Fig. 1), or of plain or corrugated metal ribbon, give satisfaction; for although the loops were certainly shortened in this way, there were other drawbacks which caused us to abandon the construction. It soon became apparent that the one road to success lay in the direction of dividing the filament into a number of short straight lengths supported at their ends by insulated holders. In this manner we succeeded at last, in September, 1903, in producing the first really serviceable lamps for about 110 volts. This lamp is illustrated in Fig. 2, and it will be seen that it contains two glass discs cast to a central wire holder; each disc carries laterally 12 arms having small hooks at their ends and insulated from each other. Through these 24 hooks the thin tantalum wire is drawn up and down between the two discs. This is believed to be the first metallic incandescent lamp for nearly 110 volts which, like the common carbon glow lamp, can burn in any position whatsoever. This lamp supplied about 30 Hefner candle-power on a 94-volt circuit at 1·5 watts per candle power. It lasted for 260 hours and lost during that time 9·5 per cent. of its illuminating power.

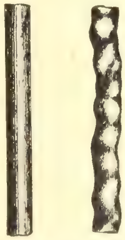


FIG. 5.—TANTALUM FILAMENT, BEFORE AND AFTER 1,000 HOURS' USE.

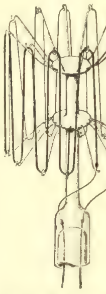


FIG. 6. FILAMENT FRAME OF A NEW LAMP.

After this first practical success we redoubled our efforts to improve the lamp further. As far back as about the middle of

October, 1903, we succeeded in making the first 200-volt tantalum lamp, which was of a design similar to the lamp just described, but with 18 arms on each disc and with a greater distance between the two discs. I may add at once that it is of interest only as a curiosity, for it has served no practical purpose. The length of its filament was 1,350, mm. and the illuminating value about 60 Hefner candle-power. In the course of further development the form of the frame of wire filament for the 110-volt lamp went through different stages, the principle of subdivision being always followed. Among other constructions we tried some in which, instead of one long filament, a number of short pieces of wire were fixed on a supporting frame; these pieces, connected in series, made up the total length required. Fig. 3 represents a lamp thus constructed, the wire being fixed obliquely in 16 straight pieces between two insulated supporting stars. Such lamps offer the advantage that short pieces of filament can be used in the manufacture. But they are only reliable if the wire used in the same lamp are absolutely uniform in diameter and quality. In the end we arrived at the shape represented in Fig. 4, which is for 110 volts, 23 c p. and 1·5 watts per Hefner candle-power. In this form, differing from most of the previous constructions, the central support consists of a short glass rod carrying two discs, into which the arms, bent upward and downward in the shape of an umbrella, are cast. The upper star has 11, the lower 12 arms, each upper arm being in a vertical plane midway between the vertical planes in which two adjacent lower arms lie. Between these 11 and 12 arms, which are bent into hooks at their ends, the entire length of the filament is drawn in a zig-zag fashion. Its extremities, held by two of the lower arms, are connected with the foot of the lamp by means of platinun strips.

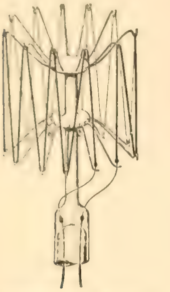


Fig. 7.—Appearance of Filament After Having Been in Use.

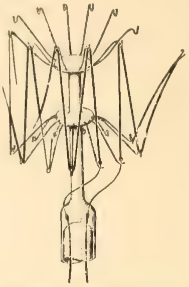


Fig. 8.—Filament Frame, Showing Broken Filament.

The standard type for 110 volts 25 Hefner candle-power and 1.5 watts per candle-power has a filament 650 mm. long and 0.05 mm. in diameter. The weight of this filament is 0.022 grammes, so that about 45,000 lamps contain together 1 kg. of tantalum. The shape of the glass globe is adapted to the frame described above. Care has been taken to make it of a size not exceeding the usual maximum dimensions of common incandescent lamps of the same candle power (25 Hefner candle-power 110 volts). This shape offers a number of noticeable advantages. In the first instance it is very stable and will stand strong shocks without damage to the lamp. A considerable number of such lamps sent across the sea to test their ability to withstand the hardships of transport came back unhurt, although they had been packed just like common glow-lamps, and no special care in any respect had been taken in their handling. The lamp burns, of course, in any position, and can therefore be held in any kind of fitting. The light is rather white and agreeable, and its effect is particularly uniform if the lamp is provided with a ground-glass globe.

We shall now proceed to describe the electric and photometric properties of the lamp and its behaviour in actual use. Numerous trials for lengthy periods of time at 1 to 3 watts per candle-power have proved the vast superiority of the tantalum lamp over the carbon filament lamp under equal electric and photometric conditions. Expressing this fact in figures, we can state that the tantalum lamp consumes about 50 per cent. less current at the same voltage, with the same intensity of light and the same useful life; or that, at the same economy, its life is several times that of the carbon type. Moreover, at an initial efficiency of 1.5 volts per Hefner candle-power the tantalum lamp has an average life quite sufficient for all practical requirements, so that this rating has been standardized for the 110-volt lamp. Trials have also proved that the lamps have a life of several hundred hours at 1 watt per Hefner candle-power, but in that case they were very sensitive to variations of pressure, and often showed an early decrease of illuminating power. The useful life of the tantalum lamp—*i.e.*, the time within which it loses 20 per cent. of its initial illuminating power—averages between 400 and 600 hours at 1·5 watts per Hefner candle-power. Some specimens have proved to have a useful life of as much as 1,200 hours. The absolute life, in general, amounts to 800-1,000 hours under normal working conditions. Further we have to remark that the tantalum lamp blackens but little unless it has been strongly overheated during work in consequence of partial short-circuiting of the filament.

It is very interesting to observe the behaviour of the tantalum lamp during the whole course of its life. The first fact worthy of note is that, like some carbon lamps, the illuminating value increases at the beginning, generally after a few hours, by 15 to 20 per cent. In the same way the consumption of current rises by about 3 to 6 per cent., while the consumption of energy drops to 1·3 to 1·4 watts per candle-power. After that, the illuminating value gradually decreases, while a corresponding increase of the consumption of energy occurs. The average behaviour of the 25 c.p. lamp at 110 volts with reference to its various periods of life is shown in the following table:—

Life in hours.	Intensity of light in Hefner c.p.	Consumption of current in amperes.	Watts per Hefner c.p.
0	25–27	0·36–0·38	1·5–1·7
5	28–31	0·37–0·39	1·3–1·5
150	25–27	0·36–0·38	1·5–1·6
300	22–24	0·36–0·38	1·6–1·7
500	20–22	0·36–0·38	1·9–2·0
1,000	18–20	0·35–0.37	2·1–2·2

The initial increase of illuminating value and of current consumed is doubtless caused by a change in the structure of the tantalum wire, this change being accompanied by a reduction of resistance and, consequently, of the phenomena resulting therefrom. We may say at once that after a certain amount of use the filament presents a radical change in appearance when viewed with the naked eye. While the fresh filament has a perfectly smooth and cylindrical surface, it acquires a peculiarly glistening aspect as it grows old, so that a lamp having served for some time can be readily distinguished from a new lamp. When looked at under the microscope, the filament that has burned for a length of time shows a clear tendency towards contraction and formation of drops or beads. Fig. 5 is an illustration of a piece of filament in its fresh state and of the same piece after 1,000 hours of service, the specimen in each case being magnified 100 times. This gradual shortening of the filament can also be observed in the lamps themselves, and offers a further indication of the age of a lamp.

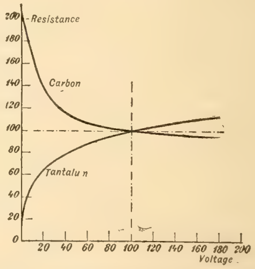


Fig. 9.—Variation of Resistance with Voltage of Tantalum as Compared with Carbon.

Fig. 6 represents the filament frame of a new lamp. It will be noticed that the tantalum wire is led up and down and hangs loose on the supporting frame in easy wide arches, without sharp bends. But after being used for some time the aspect of the lamp is quite different. As shown in Fig. 7, the wire has contracted, the wide arches have disappeared and sharp-pointed angles have taken their place.

The behaviour of these lamps is most peculiar when the filament has burnt through. While with all other incandescent lamps the burning through of the filament is tantamount to the economical death of the lamp, it may happen with tantalum lamps that they burn through several times without being rendered useless; on the contrary, each burning through is followed by an increase, often considerable, of the illuminating power. This peculiar result is due to the fact that in many cases a broken wire comes in contact with its neighbour, so that the circuit is again established. A part of the filament is thus cut out of the circuit, and the lamp consequently burns more intensely, and sometimes even too intensely, in which case, of course, only a short span of life is left to it. Yet we have had more than one lamp under observation, the filament of which broke for a first time after a short period of service and then broke repeatedly, but notwithstanding this the lamp lived more than 1,000 hours. We have often succeeded in rendering a lamp with a broken filament serviceable again by tapping it to bring the broken piece into contact with its neighbour. Fig. 8 represents the frame of a lamp in which the filament was burnt through in three places, and yet continued to do service. For the sake of clearness, the back spans of the filament have been omitted in the drawing, while the front spans which were carrying the current are drawn in specially heavy lines.

It must further be mentioned that after serving for some time, say 200 to 300 hours, the tantalum filament loses a great deal of its mechanical resistance; while, as has been stated by Dr. V. Bolton, tantalum wire, when new, has a greater tensile strength than steel; it becomes brittle, and will break easily in the course of its life as a filament. It is therefore advisable when lamps have served for some time not to remove them from their old fittings and put them into new ones, as that might easily cause the filament to break. New lamps are not very sensitive to strong shocks, even while burning, but when this alteration in the filament has occurred it is well to preserve them from shocks.

The behaviour of the tantalum lamp under a very great increase of voltage is of special interest to the incandescent lamp maker. As was to be expected, the trials made in this respect have also shown the superiority of this lamp over the carbon lamp. It has been ascertained that tantalum lamps for 110 volts, 25 Hefner candle-power and 1·5 watts per candle-power only burn through at 260 to 300 volts if the pressure is increased slowly and gradually, while with carbon lamps designed to work under the same conditions nothing like that figure can be obtained. The superiority of the tantalum lamp over the carbon lamp with regard to blackening of the glass globe can also be proved in a few hours by means of comparative burning tests at about 30 per cent. overload.

Another advantage of the tantalum lamp over the carbon lamp is that the resistance of tantalum, like that of all other metals, strongly increases with the rise of temperature, while carbon is known to diminish in resistance when it is hot. In Fig. 9 the variation of the resistance of tantalum and of carbon as a function of the voltage is graphically represented, the pressure being assumed as 100 volts and the resistance at 100 arbitrary units when the efficiency is 1·5 watts per Hefner candle-power, so that for each per cent. of variation of voltage the respective percentage of variation of resistance is shown. It will be seen in the first instance that the resistance of the tantalum increases to more than five times its original value from the cold state to 1·5 watts per Hefner candle-power, while the resistance of the carbon decreases to about one-half of its initial value. It will further be noticed that even afterwards the resistance of tantalum goes on rising, while the resistance of carbon keeps dropping. Therefore the increase or decrease of pressure causes the strength of current, and with it the illuminating value, to rise or fall at a quicker rate in the carbon lamp than in the tantalum lamp, and, consequently, the latter is less sensitive to variations of pressure than the former.

Having thus related the whole history of the development of the tantalum lamp, and fully entered into a critical comparison between it and the carbon filament lamp, we need scarcely add that we do not intend, of course, to be satisfied with what we have already obtained. For the time being, however, and until a larger building has been erected for the production of tantalum, our firm has resolved to keep to the type for which there is an immediate practical demand. That is the lamp for 100 to 120 volts, which supplies 25 Hefner candle-power at 110 volts, or will have a higher or lower illuminating value if worked at correspondingly higher or lower voltages. In conclusion I would recapitulate the properties which we claim as peculiar characteristics of our invention as follows :—

1. The tantalum lamp has a filament made of a metallic conductor and burns at once on being connected without any previous heating.

2. The light-giving wire is prepared by melting in a vacuum and drawing; it is tough even in the cold state, and can therefore be coiled and fixed in the lamp when cold.

3. A relatively great length of wire can be placed in a simple manner within a bulb of ordinary dimensions.

4. Tantalum ore exists in considerable quantities and can be easily procured.

5. Similar principles of treatment can be adhibited to other metals of a very high melting point.

TRADE NOTES.

The Montreal Light, Heat and Power Company have just given a contract to the Sunbeam Lamp Company, of Toronto, for their supply of lamps for the next three years.

The Babcock & Wilcox Company, of Montreal, have secured the contract to supply two h. p. water tube boilers for the waterworks pumping station at Winnipeg, Man. Their tender was $14,750.

The Rosebank Lumber Company have ordered two 100 horse power return tubular boilers to be fitted with Dutch ovens for their saw mill at Douglastown, N.B., from the Robb Engineering Company, of Amherst, N. S.

The Borden & Selleck Co., 48 East Lake Street, Chicago, make a specialty of manufacturing and installing conveying and elevating machinery for all purposes. Those of our readers who may be interested are referred to their announcement in this paper and are invited to open correspondence with them.

The Manitoba Iron Works, Limited, of Winnipeg, have under construction in their boiler shop a tubular boiler 7 feet in diameter, 18 feet long, shell 9-16ths of an inch, with head ⅝ of an inch, eight rows of rivets and 106 4 inch tubes. The boiler is guaranteed for a working pressure of 140 pounds and will be installed in the new sash and door factory of the Rat Portage Lumber Company.

We understand that the Syracuse Smelting Works, of Montreal, are receiving some very large orders for their "Manganese" anti-friction metal. This metal is adapted for all classes of electrical machinery, and although it has not been on the market very long, it is having a large sale. The company are sending on application miniature bars of this metal, which can be used as a paper weight.

Mr. John S. MacLean, B. A., who for thirteen years has been a member of the editorial staff of the Toronto Globe, was recently appointed manager of the publicity department of Allis-Chalmers-Bullock, Limited, Montreal. Mr. MacLean is well qualified to discharge his new duties and his wide knowledge of newspaper work should make him a valuable addition to the large staff of Allis-Chalmers-Bullock.

The Syracuse Smelting Works, of Montreal, are sole agents for the Montreal Copper Company, who are always in the market for old copper wire, which they use for eliminating sulphur from copper ores. The Montreal Copper Company is the only concern in Canada that is producing refined ingot copper and they have lately received some very large orders for export, including one for 200,000 pounds of refined ingot copper for shipment to Germany.

Mr. G. C. Mooring, who has been with the Methodist Book & Publishing House for the past sisteen years as engineer and machinist, is leaving their services, having bought out the machinery plant and stock in trade, and also the boiler compound business of the late Wm. Sutton. Mr. Mooring will conduct a modern machine shop, making a specialty of printing and bookbindingmachinery, at 82 Adelaide St. West. He has our best wishes for success.

There has been considerable renewal of activity in mining operations in central Ontario recently and many of the companies have made large increases in their plants. The Kingston Felspar Mining Company at Bedford purchased from Allis-Chalmers-Bullock, Limited, Montreal, a hoisting plant, including a 30 double cylinder Lidgerwood engine; James Richardson & Sons, zinc miners, Mountain Grove, purchased an Ingersoll-Sergeant air compressing plant, and the Madoc Mining Company at Tweed purchased a complete mining plant, consisting of a horizontal return tubular boiler, Ingersoll Sergeant air compressor, Lidgerwood hoisting engine, etc., from Allis-Chalmers-Bullock, Limited, Montreal.

ELECTRICAL WORK IN WINNIPEG.

Western Office of the Canadian Electrical News,
720-721 Union Bank Building, Winnipeg, March 6th, 1905.

The various branches of electrical industry in Winnipeg have during the past year been kept busy endeavoring to keep pace with the marvelous growth of the city, and it is only owing to the energy of the men in charge, backed by the financial interests behind them, that the various services have been extended to meet the demands made upon them.

The Winnipeg Electric Railway Company has, of course, felt the pressure the most—constant additions have been made to their plant and rolling stock as well as to the gas works operated by them. Recently the company have greatly increased in all departments, and they are now figuring on more extensions for the coming summer. The company have lately been amalgamated with the Winnipeg General Power Company, who have for the past two years been developing an extensive water power on the Winnipeg River some 65 miles distant from the city, and which is nearing completion. It is fully expected that this current will reach the city early during the coming fall. The company at present operate a single phase system for lighting, primaries 60 cycle, 2080 volts, and secondary wiring 110 and 220 volts. Commercial power circuits are all 500 volt D.C. The company's management have not so far encouraged the use of alternating motors, but apparently this policy may be changed in the near future, as some three phase apparatus has lately been installed. Mr. Wilford Phillips is general superintendent of the company's entire plant.

The Bell Telephone Company are just about completing a large addition to their building which will double their capacity. The company have a very complete central energy system and furnish an excellent service to about 3500 subscribers. They are making extensive additions to their underground system and are also erecting a large amount of aerial cable. The long distance system is also being pushed throughout the province and is proving very popular.

The Canadian Pacific Railway Company's telegraph department have also had a busy year. They have made large wire extensions throughout the West and have done some underground work in the city in connection with the company's new hotel and depot.

The G. N. W. Telegraph Company have been extending their service to the south, especially in their leased line system to St Paul, Minneapolis and Chicago.

The city electrical department report having had a busy year. The municipal lighting system has been extended considerably by the addition of over one hundred street arc lamps. The plant is operating 362 street arcs, 196 of which are D. C. series open 9.6 amp. and 166 series enclosed alternating 7.5 amp. Constant current transformers of the "tub" type are used on the alternating circuits, four 50 light transformers being in use. The generators consist of three Western Electric Company 100 light D.C arc machines; one 350 k.w. three phase alternating Canadian General R.F. generator, and one 60 k.w. S.K.C. two phase generator. Primary current is distributed for the lighting of about 2,000 incandescent lamps in the various civic buildings at a pressure of 2,200 volts. The city is also installing a 400 h.p. induction motor at their water works building for driving a centrifugal pump. The city has lately installed a number of series incandescent street lamps of 50 c.p. These are used on streets having long blocks without street intersections. They are connected in series with the arcs on the alternating circuits and have proven very satisfactory.

The fire alarm system now operates 116 street alarm boxes and a number of "auxiliary" boxes of the Gamewell type, which is the only auxiliary box that is approved for connecting to city circuits. The Ogilvie mills, the C.P.R. shops and buildings, and the general hospital are now equipped throughout with this valuable service. The city looks after the operation of these boxes, makes regular tests and reports and incidentally derives a revenue from the same. E.M. gongs are installed in eleven fire stations and other buildings and there are three circuits of "tapper gongs" in residences of members of the fire department. The system is operated almost entirely "manually," as there are operators on duty at all times. A branch exchange telephone service with trunk lines to central is installed in the fire alarm office so that intercommunication between the various stations can be had without going through central and all the stations can be simultaneously called in event of a telephone alarm coming in. Storage batteries are used for current supply to the various lines; the latest type of chloride accumulator type "P.T." being installed. There are five box circuits and four main gong circuits, the latter being normally all connected in series at the fire alarm office, but are so arranged that any loop can be instantly cut out in event of trouble.

Mr. F. A. Cambridge,
City Electrician, Winnipeg, Man.

The electrical department had an active year in the inspection of interior wiring. Two men are now constantly engaged on this work. No current can be used on any installation without a permit of the department. Last year 1905 permits for installation of wiring were issued covering 28,316 incandescent lamps, also motors aggregating 1808 h.p. and a number of generators for private plants, in addition to 85 interior arc lamps.

The electrical contractors of the city report having had a satisfactory year, but owing to keen competition prices have been cut down to a ridiculously low figure. Several efforts have been made to form a contractors' association, but so far unsuccessfully.

MR. F. A. CAMBRIDGE.

Mr. F. A. Cambridge, City Electrician of Winnipeg, has been a resident of the city since July, 1883, and has been engaged in electrical work for the past fourteen years, having been identified with the North-West Electric Company of that city since its inception in 1890. Mr. Cambridge resigned his position in that company in 1898 to accept the position of city electrician, an office just then created by the City Council, his duties at that time being the supervision of wiring, both exterior and interior, and inspection of street lighting. In July, 1899, he was placed in charge of outside construction of the city's municipal lighting system then being initiated. In 1902 he was instructed by the Council to install a new fire alarm system for the city—the city at that time only owning the boxes and the wiring being the property of the Bell Telephone Company, who were operating the system for the city. On the completion of the system he was placed in charge of its operation. In the fall of 1902 he was placed in charge of the operation of the city's municipal lighting plant, succeeding Mr. James Stuart, late Water and Light Commissioner. He is a past vice-president of the International Association of Municipal Electricians.

TORONTO BRANCH A. I. E. E.

The Toronto Branch of the American Institute of Electrical Engineers held two very interesting meetings during the past month. The sixteenth meeting was held at the School of Practical Science on February 24th, when Professor Rosebrugh introduced for discussion Mr. B. G. Lamme's paper on "Synchronous Motors for the Regulation of Power Factor and Line Pressure," which created a lively discussion.

On Thursday evening, March 9th, a joint meeting of the A.I.E.E. and the Engineers' Club was held at the club rooms of the latter, 96 King Street West. Mr. H. A. Moore, E.E., reviewed Mr. Mershon's paper on "The Maximum Distance to which Power can be Economically Transmitted." Before dealing directly with the paper he referred briefly to the progress of electric power transmission. With the advent of the induction motor the demand for transmitted power was increased enormously, and to-day long distance power transmission systems were being considered to supply whole districts. He believed the success of very long distance electric power transmission was closely associated with the question of whether the trunk railways in future will use electricity or steam as their motive power.

Mr. Mershon concludes that the distance which electric power can be economically transmitted depends upon economic conditions rather than engineering difficulties. Mr. Moore pointed out that in voltages, say above 100,000, many obstacles were encountered in securing proper insulation, reduction of leakage losses, etc., and the limit of distance was soon approached. It was generally admitted that for long distances large blocks of power must be transmitted at high voltages, and that the cost of developing power decided in large measure the distance which it could be economically transmitted. He knew of one power which had been developed for $50 per h.p., while many others had cost from $150 to $200 per h.p. Naturally the cheaper development would permit of the power being profitably transmitted the greater distance. The public, however, did not appreciate the great cost of delivering power after it had left the power house. Mr. Mershon, in his calculations, had assumed exceptionally favorable conditions, the cost of power at the power house being fixed at the very low figure of $10.90 per kilowatt per annum.

An interesting analysis of the curve sheets was made by Mr. Moore to emphasize the limitations under different conditions. Taking the first cost at $10.90 per h. p., and selling the power at $34, and transmitting 25,000 kilowatts at a pressure of 70,000 volts for a distance of 100 miles, the net profit on investment would be 13 per cent. If the same amount of power were carried 200 miles, the economical voltage would be raised to 85,000 volts, but the net profit would be only 7 per cent. If increased still further to 300 miles, the voltage could be raised to 88,000 and the profit would be reduced to 3 per cent. In the last instance the line loss would be 13 per cent. It would appear, therefore, that the limit of distance for a transmission of 25,000 kilowatts is 100 miles.

Taking an output of 50,000 k. w. and transmitting 100 miles at 90,000 volts, a profit of 20 per cent. is shown. For 200 miles the voltage could be increased to 100,000, and the profit would be 13 per cent., while for 300 miles, at a pressure of 105,000 volts, the profit was reduced to 9 per cent. Thus, according to Mr. Mershon's calculations, the limit for 50,000 k. w. was 200 miles.

Mr. Moore said that the above estimates, although based on more favorable conditions than would be likely to be experienced in practice, were nevertheless of great interest in Southwestern Ontario, where coal costs $1.50 per ton more than in the Eastern States. The question of the transmission of Niagara power vitally affected the development of this section of the Dominion.

In the discussion which followed Mr. Moore's remarks, the advisability of constructing storage reservoirs to maintain a constant flow of water was suggested, and it was shown that this had been done in several instances. The expediency of doing so, however, depended largely upon the cost of providing such reservoirs. Mr. Moore said that he believed the small water powers would be coupled up with the larger developments, and would be used as auxiliaries to help out during periods of low water in certain districts.

Replying to a question, it was stated that Mr. Mershon had concluded that the limit of distance of transmission would, for some time at least, be in the neighborhood of 550 miles.

Reference was made to the vast number of water powers to be found throughout almost the entire Dominion excepting Manitoba and the Territories and to the great possibilities for the engineer in the development of these powers.

On behalf of the Engineers' Club and the Toronto Branch of the A. I. E. E., a hearty vote of thanks was tendered to Mr. Moore for his presentation of the subject.

Mr. C. H. Rust, City Engineer of Toronto, Ont., is preparing data as to the cost of installing a civic electric light plant, as the contract with the Toronto Electric Light Company expires within a few months.

TELEGRAPH and TELEPHONE

CENTRAL EXCHANGE OF THE BELL TELEPHONE COMPANY, TORONTO.

With the new addition which has recently been completed, the Central Exchange of the Bell Telephone Company on Temperance street, Toronto, is, in point of arrangement and equipment, one of the most complete in America. The enlargement has permitted the company to rearrange the different offices and departments so as to secure the best possible results, which had not been possible for some time previous owing to the rapid growth of the telephone business rendering the accommodation inadequate.

The Exchange as it now stands is a three-storey pressed brick fire-proof structure having a frontage of 95 feet and a depth of 85 feet, and is sufficiently large to provide for the prospective growth of the company's business for some years to come. The entrance is at the centre of the building, and on the ground floor to the left is the business office, with the manager's office adjoining. This floor is used entirely for offices and long distance accommodation.

The second storey of the building is devoted to the power plant and distributing departments, while the upper storey is used exclusively for operating purposes.

The entire telephone service of Toronto is now operated on the common battery or central energy system, whereby the whole of the current necessary to operate the telephones is generated at the central office. Although this system is doubtless understood by most of our readers, a brief explanation of the method of operating may be instructive to some.

Miniature incandescent lamps, controlled by relays, take the place of the self-restoring annunciators formerly used. These lamps are easily seen, take up but little room, and may be placed immediately below the jack with which they are associated, thus facilitating the operator's work considerably. To signal the central office, a subscriber merely removes the telephone from its supporting hood, when a lamp connected with his line at the central office lights, drawing attention to that line; on the operator inserting the plug of one of a pair of connecting cords in the jack of the calling line, the lamp is extinguished. The operator after enquiring for the number wanted, completes the connection with the second cord. Associated with these cords are supervisory lamp signals, also controlled by the switch hook at the subscriber's station. If the cord is connected to a line and the telephone of that line is on the switch hook, the lamp associated with the cord lights up, if the telephone is off the hook the lamp remains dark; consequently the operator has a positive signal in front of her as to the condition of the line, being able to tell at a glance whether a subscriber has answered a call and whether a conversation is finished and the lines should be disconnected, or whether an error has been made and the subscriber requires further recognition.

If a subscriber, after using the telephone, leaves the receiver off the hook, he of course disconnects himself with Central. To draw the subscriber's attention to this, the wire chief is notified and inserts a plug which connects that line with what is called a "howler." On hearing this noise the subscriber's attention is drawn to his 'phone and he finds that it is off the hook. When a line is out of order a circuit is put on which notifies the operator of the trouble, but as soon as the line is in working order again the trouble test ceases to work and the operator knows that the line is ready for use.

When, during the night, the operators have an increased number of lines to look after and all the lights may not be clearly visible, an efficient service is provided by means of a night bell, which is rung when a call comes in and attracts the operator's notice to the board. Resistance lamps divide the current equally all along the switchboard so that one operator cannot take the power away from another in using one section of the board frequently. The bells on the telephone—in fact the whole signal system, which includes the "busy test" and the "howler," are operated by a special machine.

The great advantage of the central energy system is that a great deal of work is taken from the ear and given to the eye of the operator, thus permitting more efficient work.

The switchboard of the Toronto Exchange has a capacity for 9600 subscribers' lines.

MONTREAL OPERATING ROOM OF THE C. P. R. TELEGRAPHS.

The operating room of the C.P.R. Telegraphs in Montreal is one of the most modern establishments of the kind in America. There are worked from this office three duplex wires to Winnipeg, one duplex to Vancouver and various duplex and quadruplex circuits to Chicago, Toronto, New York, St. John, Halifax, Canso, Quebec and Ottawa. All cablegrams over the Pacific Cable between Australia, New Zealand and Great Britain pass through this office. In fact, telegrams circulate through it to or from all parts of the world. Current for working the wires and instruments is supplied by twelve motor dynamos, giving various strengths of current according to the length of the wires. Each machine works for eight hours and rests four; there being reserve machines for this purpose. These machines are of the Lundell type, manufactured by the Sprague Electric Company, New York. They were installed about four years ago and we are told that they have cost nothing for repairs during that time, notwithstanding that they are operated eighteen hours every day in the year.

From conversation with Mr. James Kent, manager of C.P.R. Telegraphs, it was learned that each wire before entering the switch is protected by two different fuses and a lightning arrester so as to prevent heavy foreign currents or lightning from injuring the apparatus or building.

All wires running from the operating tables pass through a distributing rack before reaching the switch. All transpositions of wires are made in this distributing rack, diagrams being kept which enable the chiefs in charge to promptly trace any wire in the office.

The switchboards are of the latest pattern, being specially designed so that no metal comes in contact with any part of the wood-work. They are equipped with what is known as the "Skirrow" extension cord.

The messages are carried from the receiving room to the operating room in pneumatic tubes; a bell ringing in the receiving room indicates that the carrier has reached the operating room. In the delivery department a small motor drives a pair of rollers for the purpose of taking impression copies of all telegrams received.

A new call box system has just been established. It is the most up-to-date system in Canada, and although the installation was only commenced about three months ago, over 1,000 boxes are now in operation throughout the city.

ANNUAL MEETING OF THE BELL TELEPHONE COMPANY.

The statement issued at the twenty-fifth annual meeting of the Bell Telephone Company, held in Montreal last month, shows that the company now operate 475 exchanges and 789 agencies, with 66,160 sets of instruments earning revenue. During the year 1904, 8,988 new subscribers were gained, and 1,242 miles of wire added to the long distance system, which now comprises 32,211 miles of wire on 7,866 miles of poles.

The total receipts for the year 1904 amounted to $2,838,000; the expenses including bond interest, etc., totalled $2,231,000. The net revenue for 1904 was $701,000. Of this sum the dividends took $588,000, leaving the sum of $113,000, which was carried to reserve, accident and contingent account.

The president, Mr. C. F. Sise, stated that in 1885 the long distance mileage amounted to 2,000 miles; today it is 32,000 miles; ten years ago there were 69,000,000 exchange connections during the twelve months, now there are 228,000,000 during the same period. Ten years ago the subscribers throughout Canada numbered 29,000; to-day there are 66,000 instuments earning rental. He stated that the company would move into their new building in Montreal on May 1.

The President said that much criticism had been caused by the introduction of the slot telephone. These machines had been introduced for the reason that certain subscribers had not lived up to their contract, which does not permit a use of the telephone by the general public. He remarked that within three days of the time the slot machine was introduced into saloons, cigar stores, etc., different firms had come and subscribed, indicating that they had for years been conducting their business over their neighbors' phones.

The board of directors and the officers were all re-elected, as follows:—C. F. Sise, president; Hon. Robert Mackay, vice-president; E. P. Fish, Robert Archer, Wm. R. Driver, Hugh Paton, Charles Cassils, Thos. Sherwin.

SHORT-CIRCUITS.

A telephone company is being organized, with a capital of $25,000, to construct a telephone system in the Temiskaming district.

The Board of Trade of Orillia, Ont., has appointed a special committee to gather information with a view to the installation of a municipal telephone system in that town.

Steps are being taken looking to the construction of a rural telephone system in Waterloo County, Ont. A special committee has been appointed to report upon the cost.

The Nanaimo Telephone Company, Nanaimo, B. C., has been absorbed by the British ColumbiaT elephone Company, and it is understood that extensive improvements will be made by the new owners.

The Bell Telephone Company will this spring commence the erection of a new telephone exchange on Clarence street, Kingston, Ont. It will be a two-storey building, with grey pressed brick front, and will cost about $30,000.

The International Telephone Company has been registered in British Colombia as an extra-provincial company, with local head office in Vancouver. The company has a capital of $50,000, their general headquarters being at Bellingham, Wash.

The C. P. R. Telegraph Company have made arrangements to erect one thousand miles of copper wire and eight hundred miles of ordinary wire during the coming season. Most of the lines will be built in Western Canada, including a fourth line from Winnipeg to Vancouver, B. C.

Incorporation has been granted to the Markham & Pickering Telephone Company, Limited, with a capital of $40,000 and head office at Whitevale, Ont. The provisional directors are Messrs. A. Hoover and D. R. Beaton, of the township of Pickering, and A. C. Reesor, of the township of Markham.

The Scarboro Telephone Company, Limited, has been incorporated at Toronto, with a capital of $40,000. Permission is given to carry on the business of a telephone company in the counties of York and Ontario. The directors include Dr. T. A. Young, of Markham, and William Mulock, jr., of Toronto.

A veteran telegrapher died in Montreal on February 16th, in the person of Mr. James Poustie. Deceased came to Canada from Scotland and entered the employ of the Montreal Telegraph Company, steadily advancmg from clerk to the position of superintendent of construction. He was widely known all over the Dominion.

The Richibucto-Rexton Telephone Company, Limited, has been incorporated by the New Brunswick Government, to acquire the telephone systems of the Kent Electric Company, Limited, and the Kent Telephone Lines Company, Limited, and to construct telephone systems in different parts of that province. The capital stock is $20,000, and Willlam J. O'Leary, electrical engineer, of Montreal, is one of the promoters.

PERSONAL.

Mr. George L. Oill has been appointed manager of the electric light and gas plants controlled by the corporation of St. Thomas, Ont.

Mr. Wright, superintendent of the St. Johns Electrlc Light Company, St. Johns, Que., has resigned, and Mr. S. E. Fletcher, for a number of years electrician of the company, has been appointed superintendent.

Mr. A. M. Townsend, formerly of Halifax, N.S., but for some years connected with electric railways in the United States, has been appointed general superintendent of the Cape Breton Electric Company, of Sydney, N.S.

Dr. Jack has tendered his resignation as Dean of the Engineering Faculty of the University of New Brunswick at Fredericton, and has accepted the position of city engineer for a city in Virginia, at a salary of $2,200 per annum.

The many Canadian friends of Mr. P. G. Gossler, late of the Montreal Light, Heat & Power Company, Montreal, will be pleased to learn that he has been elected one of the Vice-Presidents of J. G. White & Company, the well known engineering firm of New York.

Mr. J. M. Buntzen, general manager of the British Columbia Electric Railway Company, left recently on a flying trip to England to consult with the directors of the company regarding the electrification of the Lulu Island branch of the C. P. R., which was recently acquired by the company.

Mr. G. B. McBurney, widely and favorably known as travelling representative in Eastern Ontario for the Canadian General Electric Company, has been appointed manager of the Winnipeg office of that company and has already assumed his new duties. Mr. McBurney carries with him the best wishes of a large circle of friends in the East.

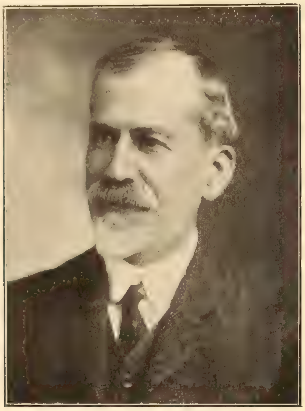
The first important change to be made in the staff of the Mexican Light and Power Company has occurred through the resignation of Mr. Hugh Cooper, resident engineer at Mexico. Mr. Cooper has had charge of the construction works, and owing to his resignation, Mr. F. S. Pearson, vice-president and consulting engineer, has gone to Mexico to reside till all the works are completed. Mr. Cooper built the plant of the Sao Paulo Tramway, Light and Power Company.

Mr. Thomas J. Mullin, superintendent of construction for Allis-Chalmers-Bullock, Limited, Montreal, was recently married in Cincinnati. Prior to leaving Montreal he was tendered a farewell dinner at the Engineers' Club by the staff of the head office. The chair was occupied by Mr. Alfred Collyer. During the evening Mr. Mullin was presented with a handsome set of carvers and was also the recipient of a number of congratulatory telegrams from different parts of the country.

MR. GEORGE L. OILL.

Mr. George L. Oill, who has been appointed by the city of St. Thomas, Ont., to continue the management of the electric light and gas plants which the corporation expects to acquire about May 15th at a valuation of over $200,000, was born in the village of Jamestown, South Yarmouth, County of Elgin, March 22nd, 1846. With his father, he removed to the historic Quaker village of Sparta, where he received a good common school education. After arriving at the age of manhood he located in St. Thomas, the county town of his native county, where he has resided continuously up to the present.

While pursuing commercial industries, Mr. Oill has devoted his energy to the advancement of the interests of the city, having been a representative on the Council Board for a number of years and filling the position of Chief Magistrate for two years. During his term as Mayor a monetary transaction by which the city profited to a large extent was arranged, namely, the sale of the city's bonds in the London and Port Stanley Railway for an amount of $40,000, which bonds as an asset were considered almost valueless. He was largely instrumental in securing the adoption of the frontage system of providing for permanent street improvements, the outcome of which has been the construction of substantial and beautiful streets.



MR. GEORGE L. OILL,
Manager Electric Light and Gas Plants, St. Thomas, Ont.

Ten years ago Mr. Oill was offered the position which he has since filled as manager of the gas and electric light plants. These plants have been rebuilt and enlarged on three different occasions under Mr. Oill's supervision; larger and more efficient engines and dynamos have been installed in the electric department, and increased manufacturing capacity in the gas department was completed last year. The combined plants are now capable of taking care of the light and power business of the city much more satisfactorily than in previous years.

While Mr. Oill was not an advocate of municipal ownership of lighting plants, he believes there is no reason why the business should not prosper and flourish under the city's control so long as favoritism and "log rolling" are not indulged in.

The Fairville Electric Light Company, Limited, are seeking incorporation to light the village of Fairville, N.B. James Ready is one of the promoters.

MONTREAL

Branch office of CANADIAN ELECTRICAL NEWS,
Imperial Building.

March 8th, 1905.

Electric door bells out of order have been a chronic complaint in Montreal; a new annoyance has cropped up in the shape of factory telephones. Poor wire, cheap intercommunicating instruments, and bad installation are to blame. It is noteworthy that wiremen do not take the care they should in installing circuits operated by power from batteries, whereas in some respects more care even should be taken than for electric light wiring.

A case is now with the court in Quebec where the Quebec Railway, Light & Power Company are being sued by an insurance company for damages resulting to a house by fire through electric origin. It is claimed that the transformer broke down and that the primary current was carried into the residence, causing the damage. The experts for the Lighting Company were Mr. R. S. Kelsch, E. E., and Mr. J. M. Robertson, of the Montreal Light, Heat & Power Company. Those for the insurance company were Mr. W. J. Plews and Mr. Leonard, all of Montreal. The verdict has at date of writing not been rendered.

It has been decided that Montreal will be Edison sockets and 110 volts after May 1st, 1905. The company are to be congratulated on this decision, as it simplifies stock for the supply dealer. Although the bulk of standard supplies are now to our credit "made in Canada," yet novelties are often purchased the other side of the line and which invariably are put on the market first to suit their standard over there, which is now the same in Montreal. There is also, we believe, some slight royalty on the use of porcelain T.H. bases which all manufacturers have now adopted and which will be eliminated by the use of Edison.

The Montreal City Council, in debating the removal of snow from the streets, have made a statement to the effect that the Montreal Street Railway Company will not take the contract for the work unless granted a long extension of franchise. The company, however, are business men and have never had a chance to tender for it on a monetary basis, and even were they paid a good round sum for such service it could not possibly come more expensive than the present method of "tea chests upon sleighs," the average load of which is about ten shovelfuls.

It would be interesting to know what it has cost the city to collect the $5.00 tax on "each establishment using motors"; also what the Manufacturers' Association are doing about its recollection during 1905?

A company with a modern plant and 84 feet head of water have lately commenced operations at the Chasm at Chateauguay N.Y. As this is but 7 or 8 miles from our border towns, they are offering to transmit energy to some of them.

A rumor has reached us that the genial Fred Thomson contemplates setting sail on the sea of matrimony about the middle of June next, and immediately thereafter will embark with his bride on a pleasure trip to England. His many friends wish him *bon voyage*.

The main Bell Telephone exchange are showing that "Centra Energy" is on the wing. Their men are out now installing condensers.

The main exchange of the Merchants Telephone Company, situated at 80 St. Lawrence street, was completely demolished in the fire there lately. The damage was $18,000; covered by insurance. The fire started in Tuckett's cigar factory under the exchange. A building on Vitre street has been secured and will be fitted out to replace the St. Lawrence street office as quickly as possible. They have two other small branch exchanges in other sections of the city which helped out considerably. The whole concern is said to be controlled by New York capitalists.

Wiring contractors galore still remain in Montreal, some being "of a sort." True, some die out in the winter, but a fresh crop sprout with the spring. They number somewhat like 93 and those of financial responsibility might readily be counted on the fingers of one hand. The reason for this fungus growth is not hard to find. Let any reputable contractor discharge a wireman, say, owing to work being scarce; he visits a supply dealer, confides to him that he will probably start "on his own hook." "Good," says Mr. Dealer, "you can run credit here"—this in many cases without knowing whether the wireman has a cent to his name. Yes, even to four figures has been offered. The dealer then wonders why he does not have more support from the five wise virgins.

As to the supply dealers themselves, make a round of them, get a 20 cent price from one, the next will better it by a cent, the next by another, and so on till their absolute cost is reached. As to trade protection, it exists, but a telescope is required to find it; why, as high a protection as one-quarter of one per cent. is thought good in not a few lines.

A telephone message to a supply house lately to "send up a wagon load of electricity to thaw out my water pipe" was referred to the Montreal Light, Heat & Power Company, whose outfit has done good work in that line.

STUDENTS' DINNER.

The annual dinner of the students of the School of Practical Science, Toronto, was held at the King Edward Hotel on Tuesday evening, March 7th. About three hundred students and guests were present. Mr. A. E. James, president of the Engineering Society, presided. The following responded to the toasts: "Canada and the Empire," Hon. Dr. Montague; "The Legislature," Thomas Gibson, Director of the Bureau of Mines; "Canadian Industries," W. K. George; "Faculty of Applied Science," Principal Galbraith and Prof. Stewart; "The Engineering Profession," W. T. Jennings, E. J. Laschburger and F. M. Somerville; "University of Toronto," Prof. Baker and C. H. Mitchell; "Sister Institutions," E. A. Collins, of McGill, J. Archibald, of University of Toronto, A. Fraser, of Wycliffe, W. A. Walden, of Victoria, W. H. Caverhill, Dental School, and A. G. McPhedran, Medical Department; "Our Graduates," Max. Sauer and A. B. Chase. Among those present were a party of twenty-five from Niagara Falls.

CANADIAN FAIRBANKS COMPANY.

The business of The Fairbanks Company in Canada, including all their selling agencies, contracts, organization and warehouse stocks of goods at Montreal, Toronto, Winnipeg and Vancouver, has been purchased by Mr. Henry J. Fuller.

Mr. Fuller started the business for The Fairbanks Company in Canada six years ago, and since that time it has rapidly grown; The Fairbanks Company not seeing their way clear to manufacture in Canada, Mr. Fuller offered to buy the business in order to re-organize it as a Canadian institution, and the business will be conducted, on and after March 15th, as The Canadian Fairbanks Company, Limited, Mr. Fuller being president and treasurer. It is his intention to begin very shortly the erection of a large plant for manufacturing the many specialties which they have heretofore imported.

The first step will be to remove the Montreal warehouse into new quarters at 444-446 St. James street on the first of May next, the old quarters on Craig street being retained for the present, as it is expected the extra space will be needed for the increase of business.

MOONLIGHT SCHEDULE FOR APRIL.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Apr. 1	7 00	Apr. 2	5 00	10 00
2	7 00	3	5 00	10 00
3	7 00	4	5 00	10 00
4	7 00	5	5 00	10 00
5	7 00	6	5 00	10 00
6	7 00	7	4 50	9 50
7	7 00	8	4 50	9 50
8	7 00	9	4 50	9 50
9	7 00	10	4 50	9 50
10	10 20	11	4 50	6 30
11	11 10	12	4 50	5 40
13	0 00	13	4 40	4 40
14	0 45	14	4 40	3 55
15	1 30	15	4 40	3 10
16	2 10	16	4 40	2 30
17	2 40	17	4 40	2 00
18	No Light	18	No Light	
19	" "	19	" "	
20	7 15	20	9 45	2 30
21	7 15	21	10 50	3 35
22	7 15	23	0 00	4 45
23	7 15	24	1 00	5 45
24	7 15	25	1 45	6 30
25	7 20	26	2 30	7 10
26	7 20	27	3 10	7 50
27	7 20	28	3 45	8 25
28	7 20	29	4 10	8 50
29	7 20	30	4 10	8 50
30	7 30	May 1	4 10	8 40
			Total............	190

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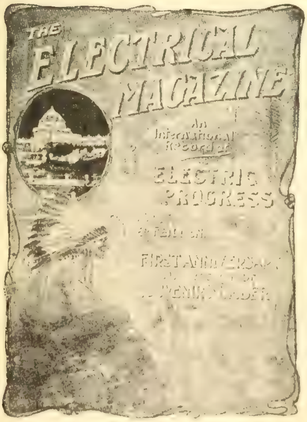

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CANADIAN ELECTRICAL PATENTS.

Below will be found a list of Canadian patents granted during the past month for devices connected with the electrical industry, furnished by Messrs. Fetherstonhaugh & Company, patent solicitors, of Ottawa, Toronto, Montreal, New York and Washington:

E. Thompson, Swampscott, Mass., diaphragm actuated mechanisms; S. E. Flichtner, Englewood, N.J., starting systems for gas or vapor electric devices; H. R. Stuart, Wilkinsburg, Pa., potential regulators for alternating current circuits; H. R. Stuart & A. B. Rynders, time limit for electric circuits; A. Weber & J. Weber, Schenectady, N.Y., incandescent electric lamp sockets; G. E. Johnston, Fort Wayne, Ind., electric interrupters for high frequency currents; J. H. Goebst, Chicago, Ill., electric lamp sockets; C. W. S. Turner, Mountville, Va., electrically operated block signalling apparatus; C. E. Scurbner, Chicago, telephone exchange system; T. Emphrat, Dariem, Conn., electric trolley wheels; P. C. Hewitt, New York, means for reproducing electrical variations; P. C. Hewitt, method of reproducing electrical variation; P. C. Hewitt, electrodes for vapour electric apparatus; I. de Kaiser, Pittsburg, Pa., coils for electrical machines; A. J. Hart, Montreal, firemen's signalling system; J. F. Weinschenk & C. H. Blodgett, Durand, Mich., electrical signalling devices for railroad crossings; W. J. Ronssel, New Orleans, Louisiana, electrically operated typewriters; A. A. Bell, Jr., Lynn, Mass., pumps; L. A. Osborne, Pittsburg, Pa., field magnet coils for electrical machines; F. J. Lindman, Pittsburg, winding for electrical machines; B. G. Lamme, Pittsburg, single phase alternating current motors; B. G. Lamme, power systems; B. G. Lamme, methods of utilizing single phase alternating current energy; W. L. R. Emmett, Schenectady, N.Y., systems of lubrication for elastic fluid turbines; S. E. Flichtner, Englewood, N.J., methods of starting gas or vapor electric devices; N. W. Rogers, Mt. Vervon, N.Y., systems of electrical distribution.

SPARKS.

The Grand Trunk Railway Company are said to have placed an order with the Westinghouse Company for six electric locomotives for hauling trains through the Sarnia tunnel. The third-rail system will be used, the rail being placed on the side of the tunnel so as to offer less danger to men at work upon the track. The plans also call for a brilliant illumination of the tunnel.

The Niagara Falls Electrical Transmission Company has been incorporated at Albany, N.Y., with a capital of $50,000, to supply gas and electricity in Niagara Falls, Buffalo, Tonawanda, Rochester and other places. The directors are: Frederic Nicholls, E.R. Wood and D.E. Thomson, of Toronto, and Harry Highland and Frank A. Dudley, of Niagara Falls.

The third annual banquet and ball of the employees of the Toronto Electric Light Company was held at McConkey's on Tuesday evening, February 21st. Mr. J. J. Wright, general manager, and Mr. W. A. Nartin, secretary of the company, were present as guests. At the banquet Mr. William Bourne, superintendent, presided. About 175 persons were present and the affair was very successful.

The annual report of the Toronto Electric Light Company submitted at their annnal meeting last month showed gross earnings of $752,315 an increase of $122,05, as compared with the previous year. Expenses increased only $57,924, so that the net earnings were $64,128 larger than in 1903. The dividends paid altogether were 7 per cent., leaving $114,076 surplus profits to be added to the balance of $188,828 carried over from 1903.

Extensive improvements are contemplated in connection with the electric light plant owned by the corporation of Victoria, B.C. The proposed detailed expenditures are as follows: One new dynamo, 230 lights capacity, approximate cost $2,940; one exciter, cost $145; one switchboard, $305; one belt, pulley and clutch and fitting same, $500; three transformers of 50 lights capacity each, $1,800; 150 arc lamps, $4,500; rearranging circuits, $810. Total, $11,000.

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(a) **Names and addresses** of all the **Directors, Members of Municipal Committees and the principal Officers** connected with each works, together with their postal and telegraphic addresses.

(b) **Technical description** of each works, showing the **"system of supply,"** detailed list of the **machinery, storage cells, cables, meters, etc.,** with which the **works are equipped,** giving the **makers' names** in each case, also **the prices charged for Light, Power and Traction.**

(c) The **financial results for the last completed year of working,** showing **capital expended, revenue and costs of generation, etc.,** are **given in detail.**

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If you are interested in Electrical Works, **as a Supplier of machinery, or stores,** to Electrical Generating Stations, or Tramways, then **this is the book** which will tell you who is the **right man to write to** on the particular subject you are trying to sell. **You will not get any letters returned** marked "Not known at this address" **if you follow** the "directions given in this book."

If you are interested in the **equipment of new and up-to-date Electrical Works for either Lighting or Power,** you will get the **latest and most reliable information** as to what is being done **all over the British Empire.**

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SPARKS.

The electric lighting system of Dundalk, Ont., is under municipal control, and it is proposed to adopt the use of meters with a view to securing more satisfactory results.

During the year 1904 one thousand incandescent lamps were added to the electric light system at Glace Bay, N.S., making the total number in use 4,717. There are 240 street lights.

Mr. H.J. McDougall has purchased an interest in the Premier Electric Light & Power Company, of Wallaceburg, Ont., and has accepted the management of same.

The new electric light and power plant at Fenelon Falls, Ont., has been completed. The power house, which was constructed under the supervision of Mr. J.E. Belcher, C.E., of Peterboro, is of concrete blocks, and 800 h.p. in generators has been installed.

The Canadian Pacific Railway will install a new system of time regulation in their new general offices at Winnipeg. A contract for a master clock and thirty-two secondary clocks, to be regulated by electricity, has been awarded to D.R. Dingwall, of that city.

The Monterey Electric & Gas Company, Limited, of Toronto, has been incorporated, with a capital stock of $3,000,000, to carry on the business of an electric light, heat and power company. The incorporators are William Mackenzie, William Laidlaw, Z. A. Lash and A. W. Mackenzie, of Toronto, and H.S. Holt, of Montreal.

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RAISING STEAM IN BOILERS.

The National Fire Protection Association gives in one of its recent bulletins an account of several tests made to determine the time required to raise steam in cold boilers. In one case the time required to raise steam in a 125-hp. horozontal boiler of the tubular type was one hour and a half. The fire was lighted at 10.40 a.m., the temperature of the water being 84° F. In about 50 minutes the water reached the boiling point and at 12.10 the steam pressure had reached 50 pounds and the fire pump was started. In another case steam was raised in a horizontal tubular boiler 5 ft. in diameter and with 25 sq. ft. of grate area, to a pressure of 50 pounds, in 55 minutes. In the case of another upright boiler, with a grate area of 33 sq. ft., 50 pounds of steam was raised in one hour and ten minutes. Tests were also made on the time required to raise steam in boilers under banked fires. In the case of the first-mentioned boiler the pressure under banked fires was 50 pounds. The fires were spread and a fire pump started at the same time, and in about 13 minutes the pump was working with throttle wide open. In the case also of the first boiler the amount of coal required to keep up banked fires was found to be 732 pounds per day. The matter of handling boilers only in use during part of the day is one of importance to many central station managers. In the case of a boiler or boilers required only during a short period of peak load, it is not,of course, advisable to keep the fires banked, but as the time of use grows longer, a point is finally reached when it would pay to keep fires banked when the boilers are cut out. When this should be done can only be determined accurately by experiments, taking account of all of the items of cost. An item that should not be neglected is the greatly decreased life of a boiler when under steam only intermittently.

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Nikola Tesla was talking about his student days at Pargue.

"I remember well at Pargue," he said, "an old professor of great originality and acumen. This professor insisted on the value of a free use of the perceptive faculties, and he was always pointing out the need for this use in strange ways.

"One day, on arising to lecture, he began: 'Gentlemens you do not use your faculties of observation as you should.'

"He laid on the table before him a pot, filled with some vile-smelling chemical compound—a thick, brown stuff.

"'When I was a student, he went on, I did not fear to use my sense of taste.'

"He dipped his finger deep into the pot and then stuck the finger in his mouth.

"'Taste it, gentlemen. Taste it,' he said, smiling grimly.

"The evil pot passed round the class, and one after another we dipped our fingers in it and then sucked them clean. The taste of the thick brown compound was horrible. We made wry faces and spluttered. The professor watched us with a grim smile.

"When the pot was finally returned to him, his thin lips parted, and he gave a dry chuckle.

"'I must repeat, gentlemen,' he said, 'that you do not use your faculties of observation. If you had looked more closely at me you would have observed that the finger I put in my mouth was not the one I dipped into the pot.'"

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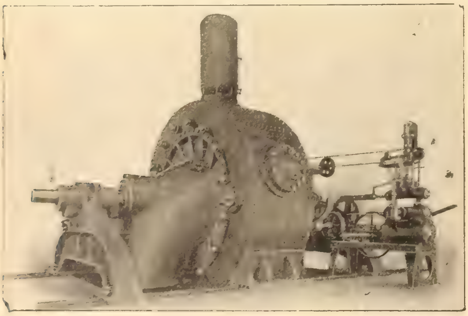

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SEND FOR TABLE OF CONTENTS

SPARKS.

A party of Montrealers went to Shawinigan Falls on February 15th to witness the starting of the new generator. This generator is of 10,500 h.p., thus giving the company a total capacity of 28,800 h.p.

The second annual report of the Electrical Development Company of Ontario, Limited, was presented at the annual meeting of shareholders in Toronto on February 13th. The directors state that the progress of the works under construction has been more rapid than expected, and that every engineering difficulty has been overcome. It is expected that the work will be completed and in operation by the summer of 1906. The transmission line of the Toronto and Niagara Power Company is nearing completion, and we understand that it is the intention of the company to proceed at an early date with the construction of an electric railway from Toronto to Niagara Falls.

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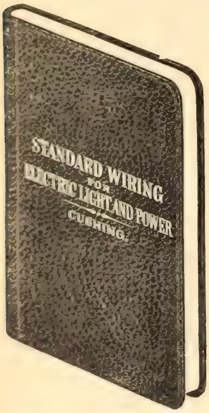

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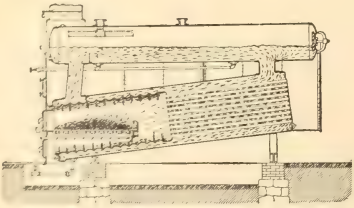

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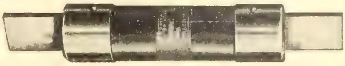

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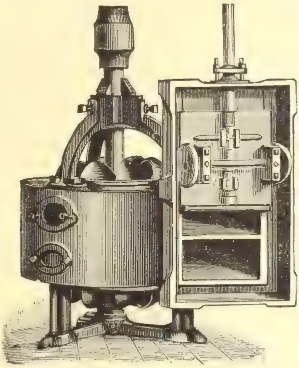

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SPARKS.

The Town Council of Prince Albert, N.W.T., have ordered a Westinghouse alternator, which will double the capacity of the plant.

Mr. Roswell C. Fisher intends erecting another new apartment building on Sherbrooke street, Montreal, in which he will install an electric plant for lighting the building.

The Cape Breton Electric Company has ordered a 150 horse power engine from the Robb Engineering Company to increase the capacity of their North Sidney power station.

The Dominion Coal Company, Sydney, N. S., are increasing their lighting plant at International Pier, and will install two sixty horse power Robb-Mumford boilers and a seventy-five horse power Robb-Armstrong engine.

The Dominion Iron & Steel Company, of Sydney, N.S., are increasing their power plant and have given a contract to the Canadian General Electric Company for two alternating current generators of 600 k.w. each to be direct-connected to two vertical engines of 850 h.p. to be supplied by the Goldie & McCulloch Company of Galt, Ont. The company intend to reconstruct their electrical equipment.

Messrs. Joseph Simpson & Sons, of Toronto, are building a power house in connection with their knitting mills, and have placed an order with the Canadian General Electric Company for a 250 k.w. 3-phase engine type alternator and twenty-six 3-phase 550 volt induction motors. The alternator will be connected to a tandem compound "Ideal" engine supplied by the Goldie & McCulloch Company, of Galt, Ont. Two new boilers are also being installed. All motor wires are to be run in Richmondt conduit in the mills and underground to the power house. It is also the intention to remodel the drives throughout the mills. The entire work is being carried out under the supervision of Mr. H. F. Strickland, electrical engineer, Toronto.

Mr. B. B. Jenkins, of Toronto, has invented a new fender which is attached to the front truck so that it is continually held about three or four inches above the ground. An automatic bar sheathed in thick rubber is in front, and the slightest pressure on this bar causes it to recoil back two or three inches and releases certain catches, which let it fall to the ground. The bar attaching the fender to the truck is made to form an effectual guard against any object getting under the wheels from the side. The bottom of the fender is made of thinly-netted ironwork, and a wire netting is placed at the back to prevent an object which is struck from falling violently against the front of the car.

The annual meeting of the Hamilton Cataract Power, Light & Traction Company was held recently, when a satisfactory statement was presented. It was shown that in 1898 the company were selling only 148 horse power, whereas they are now selling over 8,000 horse power. It was decided to proceed with the extension of the radial railway to Oakville in the spring. The following officers and directors were re-elected: Hon. J. M. Gibson, president; Jas. Dixon, vice-president; J. R. Moodie, treasurer; W. C. Hawkins, secretary and general manager; John Dickenson, ex-M.P.P., J. W. Sutherland and J. A. Kammerer, directors.

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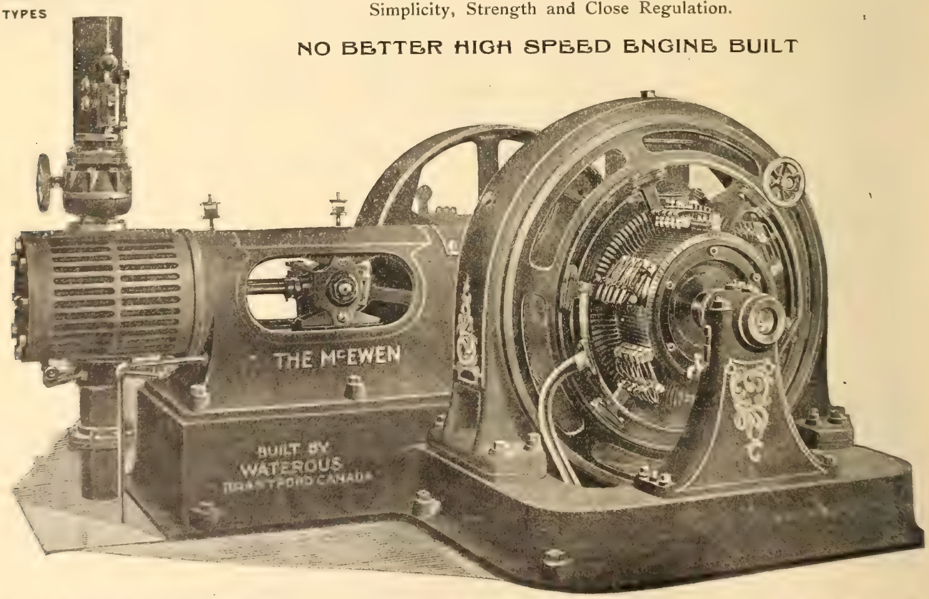
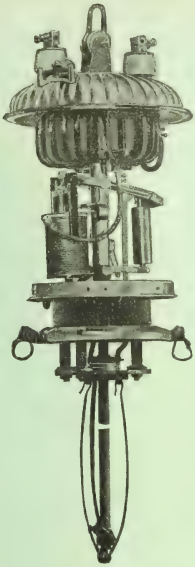
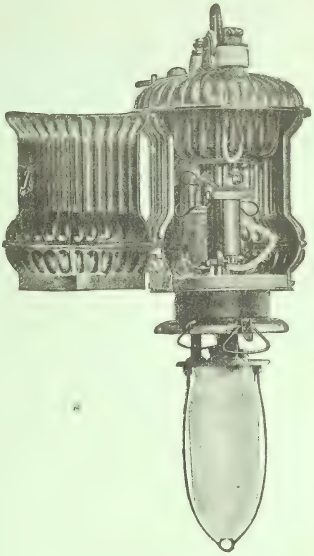


WATEROUS, BRANTFORD, CANADA



Lamp Mechanism.

Multiple Alternating Arc Lamp with Opalescent Outer Globe



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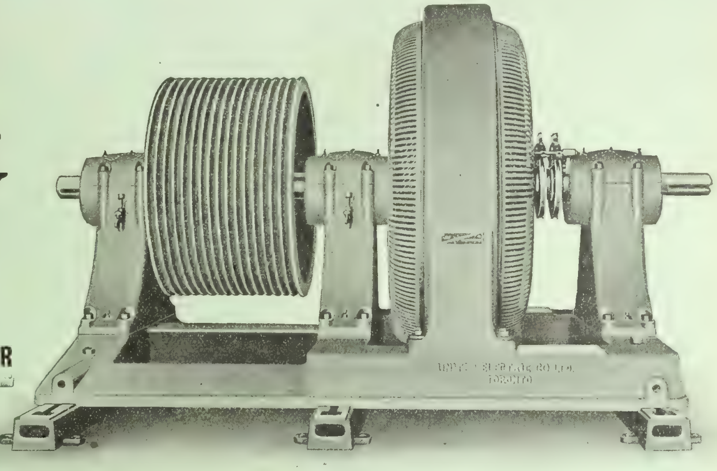

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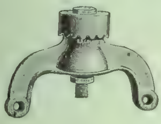

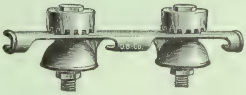

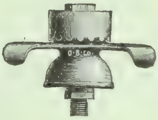

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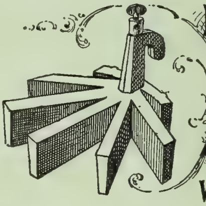

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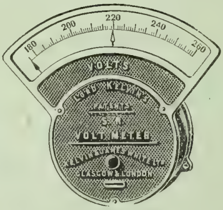

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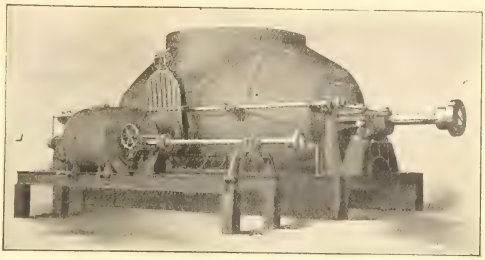

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SPARKS.

The Macleod Electric Light & Power Company, Limited, has been incorporated at Macleod, N.W.T.

Fred Wood, Sutton, Man., who will develop a water power for electric light and power and pulp mill, has retained the services of Mr. R. S. Kelsch, consulting engineer, Montreal.

Mr. F. Dagger, of Toronto, has been appointed expert to the Select Committee of the Dominion Government which is investigating the telephone systems in operation in Canada and elsewhere.

It is understood that the proposed extension of the Hamilton, Grimsby and Beamsville electric railway to St. Catharines has been abandoned for the present owing to the necessity of constructing a number of expensive bridges.

Mr. J. R. Booth, millionaire lumberman, of Ottawa, has asked the City Council for a 99 years' lease of Union Square, at the Chaudiere, where he desires to establish a 3,000 horse power steam plant to provide power for his paper mill and other industries.

The Keewatin Power Company are inviting offers for the use of electric power to be developed at the company's dam at Keewatin, Ont., and transmitted to any point within a distance of thirty miles. Mr. John Mather, of Ottawa, is one of the promoters of the company.

The Georgian Bay Power Company, Limited, of Toronto, are seeking to secure rights for distributing power from the corporation of Owen Sound, Ont. It is proposed to transmit the power from Eugenia Falls. Mr. Thomas McLaughlin, of Toronto, and Mr. B.F. Reesor, of Lindsay, are two of the promoters.

The Western Electric Light & Power Company have secured control of a water power on the Assiniboine river, about five miles east of Brandon, Man., and have had plans prepared for developing power. It is expected that between 12,000 and 15,000 horse power can be developed. Brandon citizens are the promoters.

The Fountain Condenser Company, Limited, has been incorporated at Petrolia, Ont., to manufacture steam condensers, dampers and other devices for use in boiler chimneys and smoke stacks. The capital is $40,000 and the provisional directors are Messrs. J. C. Fountain, John Schram, D. S. Robb, J. C. Winters and Isaac Greenizen.

The municipal authorities of Kingston, Ont., have fixed the following charges for electric light and power:—Light, for 500,000 kilowatt hours and under, fourteen cents net; over 500,000 kilowatt hours, twelve cents net; power, up to 100,000 kilowatt hours, ten cents; between that and 400,000, eight cents; over 400,000, six cents.

The authorities of McGill University, Montreal, are aware of the importance of keeping their students in the Science Courses informed upon the latest advances in the manufacturing world. For that purpose the leading specialists in different branches are invited from time to time to address the students. Mr. H. A. Burson, B. A. Sc., chief electrical engineer of Allis-Chalmers-Bullock, Limited, has just completed a series of addresses upon "Induction Motors," of which the company make a specialty.

The Canada-Middlesex Railway Company are seeking a charter from the Dominion Government to build an electric railway from the Niagara frontier through St. Catharines, Woodstock and Brantford to London. It is understood that the promoters are the owners of the Niagara Welland Power Company's franchise and have plenty of capital. Mr. John MacCunn, chief engineer for the company, states that the water power on the Welland river about four miles from St. Catharines is capable of developing 100,000 horse power.

The Britannia Power Company announce in a recent issue of the British Columbia Gazette the nature of their proposed works. It is proposed to dam Britannia creek and convey the water by a pipe line to the power house at Britannia Beach, where power is to be generated to operate the tramways, concentrating, crushing and other machinery, and for the purpose of scientifically operating the Britannia group of mines, about four miles inland. A tram line will also be constructed for transporting the ore from the mines to the reduction works. The estimated cost of the undertaking is $120,000.

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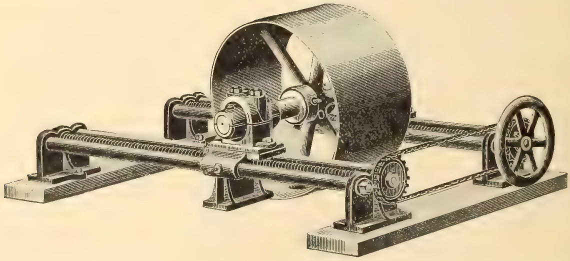

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SPARKS.

The town of St. Andrews, N. B., proposes to issue debentures for $10,000 for establishing an electric light plant.

The Electric Reduction Company, of Buckingham, Que., are in the market for second-hand direct current generators and motors.

Improvements and extensions to the electric light plant owned by the corporation of Collingwood, Ont., are under consideration.

The City Council of Hull, Que., have awarded the contract for machinery for the electric light plant to the Canadian General Electric Company.

The Fergus Electric Light & Power Company, Fergus, Ont., have recently made improvements to their plant and have installed Westinghouse enclosed arc lamps.

The British Columbia Electric Railway Company are desirous of engaging a general superintendent for their system in Vancouver, Victoria and New Westminster.

The ratepayers of Richmond, Que., are considering the taking of a backward step, as we are advised that the electric light may be abolished and gasoline lamps substituted.

The Olds Milling & Elevator Company has been formed at Olds, N.W.T., to build a 500-barrel flour mill and install an electric plant for lighting the village.

The by-law to provide for the development by the Village of Morrisburg, Ont., of 1,100 horse power on the canal at that place, was carried by the ratepayers on March 31st.

It is understood that the Brantford Electric & Operating Company intend installing a steam plant in their power house to provide relief from shut-downs on account of floods.

The following officers of the Sandwich, Windsor and Amherstburg Electric Railway Company have been elected for the current year: President, H. A. Everett; vice-president, J. C. Hutchins; secretary, A. E. Peters.

Arrangements are said to have been completed within the past month for the building of an electric railway between Chatham and Wallaceburg, Ont. Mr. G. W. Kipp and other United States capitalists are said to be at the back of the project.

Mr. R. S. Kelsch, Montreal, consulting engineer for the Lake of the Woods Milling Company, has purchased two 400 k. w. direct connected, 60 cycle, 600 volt, three-phase generators, switch-board, and nine three-phase 550 volt induction motors ranging from 25 horse power to 75 horse power, for the Lake of the Woods Milling Company's plant at Keewatin, Ont. The above apparatus will furnish power for operating their grain elevators, stave factory, cooper shop, etc.

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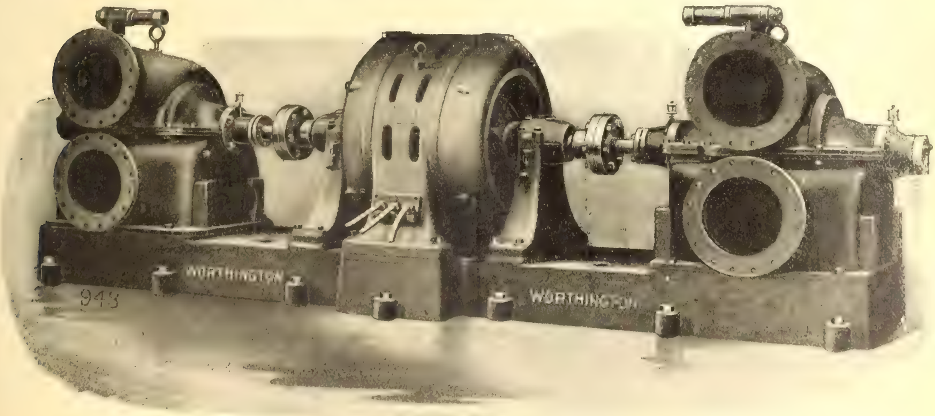

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CANADIAN PATENTS.

Below will be found a list of patents granted during the past month for devices connected with the electrical industry, which is furnished to us by Messrs. Fetherstonhaugh & Company, patent solicitors, Ottawa:

R. & G. H. Gerow, North Port, Ont., incandescent electric lamps; S. B. Flynt, Meridian, Mississippi, insulators for electric wires; M. H. Shoenberg, San Francisco, electric water heaters; I. Deutsch, Montreal, universal joints; A. C. Eastwood, Cleveland, Ohio, motor controlling system; G. S. Carson, Iowa, Iowa, electrical choke coils; R. M. Newbold, Louisville, Ky., electric lighting apparatus for railway cars; W. B. Potter, Schenectady, elastic fluid turbines; J. C. Callan, Lynn, Mass., valve mechanisms for elastic fluid turbines; R. H. Rice, Lynn, Mass., turbine wheel construction, elastic fluid turbines; F. R. Boyd, Lynn, Mass., nozzles for elastic fluid turbines; P. C. Hewitt, New York, means for amplifying electrical variarions, methods of amplifying electrical variations; E. C. Hunt, Bellplain, Iowa, cleats for electrical wiring, combination brackets and knobs for electric conductors; J. Riddell, Schenectady, universal bucket cutting machines; J. D. Price, Aurora, Ill., signals; M. C. Burt, Chicago, incandescent electric light bulbs; G. L. Campbell, Williamsport, Pa., electric railway systems; J. Burke, Erie, Pa., laminated cores for dynamo electro machines, brush holders for dynamo electro machines; P. H. Thomas, Montclair, N. J., methods of replenishing electrode waste in gas or vapor electric devices, gas or vapor electric devices, system of electric distribution, ballast device for vapor lamps; L. Bradley, Milwakuee, electric current controllers; G. F. Attwood, Wakefield, Mass., boat propellers; C. M. Fisk, Napoleon, Ohio, electric meters, process of making commutators; F. E. Phillips, Hyde Park, Mass., electric current regulators; W. A. Johnston, Toronto, electric machines.

TRADE NOTES.

The Dominion Coal Company recently placed an order with Allis-Chalmers-Bullock, Limited, Montreal, for eleven new Ingersoll coal cutters. The company had already 175 of these machines in operation.

The Simplex Engine Company, Limited, with head office in Toronto, has recently been incorporated to manufacture and deal in steam and gas engines, etc. The provisional directors are Messrs. V. L. Rice, H. L. Rodgers and G. C. Edwards.

The Truckee River General Electric Company, a large power distributing company of California operating many high potential lines, will add a 2,000 k.w. Westinghouse alternating current belt-driven generator, four 750 k.w. and four 625 k.w. transformers to their present equipment. Westinghouse low equivalent lightning arresters and choke coils are being used for the protection of apparatus and more will be added

The Wellman-Seaver-Morgan Company, with main office and works at Cleveland, Ohio, announce that Mr. Geo. B. Damon, who has been manager of their New York office, has been transferred to an important position in connection with the engineering and sales department at Cleveland, Ohio, and that Mr. W. A. Stadelman, for the past ten years manager of the eastern office of the Brown Hoisting Machinery Company, has become manager of the general eastern office of the Wellman-Seaver-Morgan Company, with offices at No. 42 Broadway, New York City.

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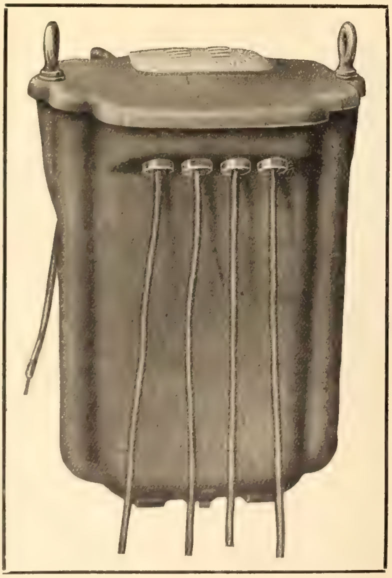

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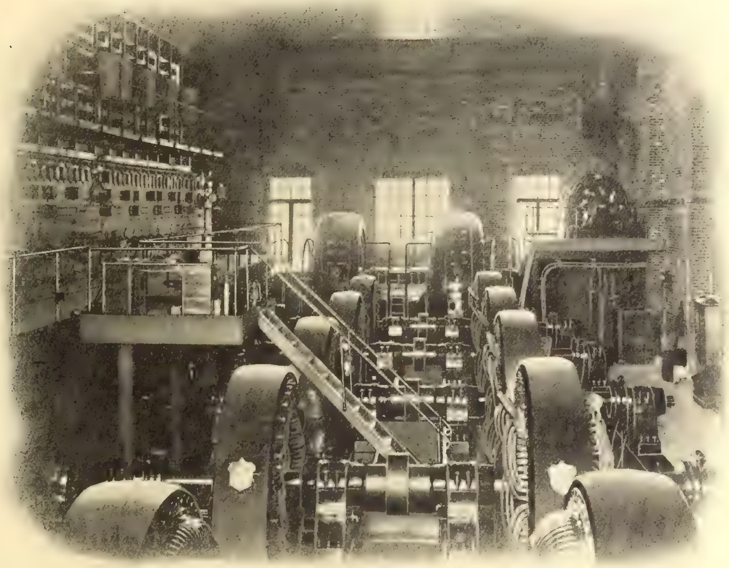

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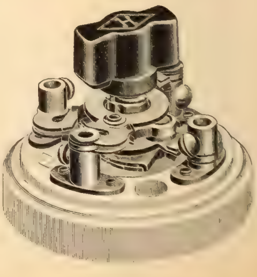

SPARKS.

The DeWitt Electric Company, of Truro, N.S., have recently established an office at Fredericton, N.B.

The Town of Napanee, Ont., will build a lighting plant and have retained the services of Mr. R. S. Kelsch, consulting engineer, Montreal.

The City Council of Calgary, N.W.T., opened tenders on March 28th for establishing a municipal electric light plant, and appointed Mr. R. S. Kelsch, E.E., of Montreal, to determine which of the three bids should be accepted. The Civic Committee reported in favor of accepting a compromise with the existing company, but this was rejected.

In the Dominion Senate recently Hon. Mr. Domville moved for the adoption of a select committee of five to enquire into the production of alumina and aluminum in Canada. He said he was fortified with all the authorities on the subject since the time of Pliny. Alumina was clay and aluminum was extracted from it by means of electricity. There was thirteen times as much of this clay in the world as there was iron, and the patents for the process expire shortly in Great Britain and the United States and never existed in Canada.

The City Council of Vancouver, B.C., have reached an agreement with the British Columbia Electric Railway Company regarding the right of way for their transmission line to be built in connection with the electrification of the Lulu Island Railway and the work will be carried to completion as rapidly as possible. The Council were influenced by a letter received from Ald. Grant, who was in Los Angeles, California, at the time. He wrote that he had called upon the City Electrician there and learned that they have no restrictions whatever on the entry of high voltage wires into that city, although there are five substations right in the heart of the city. The wires are placed overhead; in no instance underground. Station on Second street, 50,000 volts; at Plaza, 15,000 volts; corner Third and Los Angeles streets, 15,000 volts; near Park, 15,000 volts; at Fourth street, one block from Los Angeles Hotel, 15,000 volts.

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PUBLICATIONS.

Catalogue No 81 has recently been published by Allis-Chalmers Bullock, Limited, Montreal. It is devoted to illustrations and descriptions of machinery designed for the excavation of rock and ore.

Circular No. 1008, recently issued by the Canadian Westinghouse Company, Hamilton, contains much information regarding the various kinds of switchboard indicating instruments made by this company.

"Church Lighting by Electricity" is the title of a neat booklet which the Westinghouse Companies' Publishing Department have just prepared for the Nernst Lamp Company, and which will be ready for general distribution within a few days.

"Practical Methods of Electro-Chemistry," by F. Mollwo Perkin, Ph.D.: This book has been published by Longmans, Green & Company, 39 Paternoster Row, London, E. C., and sells for six shillings. The work has been some years in preparation owing to the fact that the author did not wish to include any experimental work which had not been personally tested or supervised. It is very complete and should stimulate research in connection with electro-chemical problems.

From the Waterbury Brass Company, Waterbury, Conn., we have received a very complete catalogue of the extensive line of brass, copper and German silver goods manufactured by them, such as sheets, rolls, plates, circles, wire, etc. Their seamless drawn tubing for boiler flues, pump cylinders, feed water heaters, steam pipes, etc., is meeting with a large sale. The catalogue contains many useful tables of weights and measures on brass and copper material, which should be found helpful in estimating.

"The Insulation of Electric Machines," by H. W. Turner and H. M. Hobart: This book renders available to engineers some of the results of twenty years of practical work with insulating materials and a careful study of their insulating properties. There is doubtless much to learn on the subject of insulating materials and this book should be found very instructive. The illustrations number 162. The publishers are Whittaker & Company, Paternoster Square, London, E. C., and the retail price is ten shillings sixpence.

The Canada Foundry Company, Limited, of Toronto, have published Bulletin No. 26, referring to air and gas compressors. Where electricity is available, the use of electrically driven compressors is advisable, as they are simpler and more economical in operation than any other type. The Canadian General Electric Company and the Canada Foundry Company being affiliated, complete motor-driven compressors to suit any conditions can be supplied without the usual division of responsibility. The construction of the type of compressors manufactured by the Canada Foundry Company is fully explained in the bulletin.

The Sherbrooke Power, Light & Heat Company, Sherbrooke, Que., have retained the services of R. S. Kelsch, consulting engineer, Montreal, in connection with their plans for increasing the capacity of their water power plant. The system will be changed from 133 to 60 cycles. The plans contemplate new water wheels, 750 k. w. d. c. 60 cycle generators, and direct current exciters.

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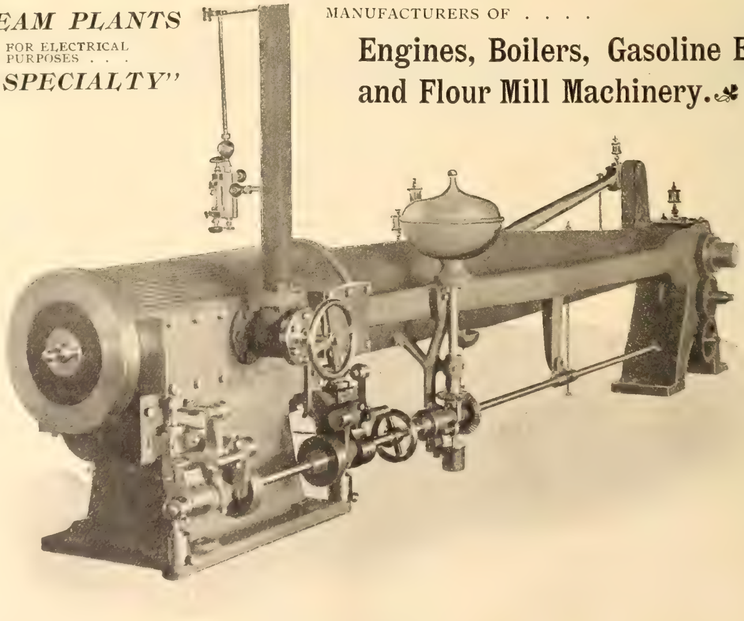

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THE CONMEE ACT.

Under the heading "Is the Conmee Act so Very, Very Bad," the Toronto Star makes the following comment:

There is no law on the statutes of Ontario that comes in for so much censure as the Conmee Act. It is usually written and spoken of as "notorious," "iniquitous," or "infamous." In the editorial columns of the press it is a target for adjectives. A great many people condemn it from hearsay, without having read it; they judge of it by the reputation its critics give it. If it is not a bad law, why does it rest under so bad a reputation?

What is the Conmee Act? It deals with gas, electric light, and waterworks. It provides that a municipality in which there is an incorporated company supplying gas, electric light, or water, shall not set up a rival system and service, but shall acquire the existing system and service by arbitration. The Conmee Act lays down the procedure by which the municipality may take possession of the plant and business of the company.

If the Conmee Act is iniquitous, the iniquity must be in the general principle underlying it, or in the details. The details seem fair enough on an impartial examination. If a town wants to take over the plant and business of an electric light company, it can name a price, and if this is not accepted by the company in thirty days, the municipality can proceed by arbitration to make the purchase. The arbitrators are instructed in the Act to allow nothing to the company for the franchise it has enjoyed, or for prospective profits, but to consider only actual present value, with ten per cent. added. When the arbitrators bring in their report, it is binding on the company if the municipality decides to proceed, but it is not binding on the municipality. A month after such an award is made the town can notify the company that it withdraws on paying costs of the proceedings, and it cannot renew the attempt to purchase for two years. If a town is buying out a company, the procedure laid down in the Act seems fair.

The iniquity of the Conmee Act must consist in the general principle of it—the prohibition it puts upon municipalities of not entering into competition with any existing company supplying gas, electric light, or water. Is this principle iniquitous? It certainly would be a most unfair thing to restrain a town from starting an electric light service of its own where a company was charging exorbitant rates, and refused to sell if there was no way to compel a sale. But the Act compels the company to sell. It makes of the service a monopoly, but it gives the municipality power to acquire possession of it, whether the company wishes to sell or not. What more does a municipality want? A town can have no desire to start up a rival electric light plant, and render valueless the property of a company. There might be revenge in this, but it would not be sound business, nor would it be fair play to those who had made the investment. In fact, towns did not do this before the Conmee Act forbade it. The law makes the sale to the municipality by the company compulsory, and this is the fact that was urged in behalf of the Act when it was passed.

A town cannot compete nor arrange for competition in gas, electric light, or water, but it is empowered to take over any or all of these services, and conduct them as municipal properties. It cannot compete as it formerly could; but it can expropriate as it formerly could not. It is the fashion to execrate this law—what's wrong with it?

The plant which the Saugeen Electric Light & Power Company installed last summer is working very satisfactorily. The power house is situated on the Saugeen river, about three miles from Southampton and five miles from Port Elgin, both of which places are lighted from this plant. The generator is a 200 k. w. Canadian General Electric A. C. three-phase machine, 6,600 volts, with revolving fields, and replaced a 120 k. w., single phase alternator. It is belt driven and has a speed of 600 r.p.m. There are two vertical turbines giving 300 h. p. under a 13-foot head. The switchboard is marble and fitted with the latest equipment, including oil break switches. Although a three-phase generator, it is at present being operated single phase. The current is transmitted at 6,600 volts to the entrance to each town, where step-down transformers of 90 and 60 k. w. capacity respectively reduce the voltage to 2,000 volts. There are supplied 1,200 sixteen c. p. lamps in Port Elgin and 1,600 in Southampton, and the streets of each town are lighted by 50 c. p. incandescent lamps. Up to the present time the company have not supplied power. The head office of the company is at Walkerton, Mr. David Robertson being president and Mr. Norman Robertson secretary-treasurer.

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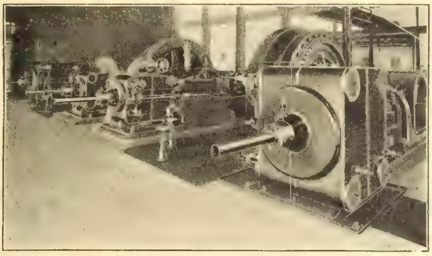
The Bell Telephone Company purpose building a new exchange in Brantford, Ont.

A party of capitalists recently visited Glenora, Ont., with Mr. H. C. Kennedy, of Wiarton, who has secured an option on the famous Lake on the Mountain at this point. It is proposed to make an electrical development of considerable magnitude, power to be transmitted to towns within a radius of fifteen or twenty miles and electric railways installed to interconnect the various towns and villages in the neighborhood. The available head is approximately 180 feet, and a test to ascertain the amount of water which the lake will furnish will be made in the near future. Mr. K. L. Aitken, of Toronto, is consulting engineer.



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May be put on a paying basis by improving its power plant.

WE ARE IN A POSITION TO MAKE THE IMPROVEMENT

We can furnish a part or the entire plant, **Engines, Boilers, Heaters, Condensers, Pumps, etc.** We build engines for either rope or belt drives or direct connection, high or slow speeds.

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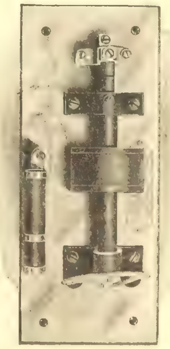
GARTON DANIELS LIGHTNING ARRESTERS



The Garton Daniels Lightning Arresters are devices made in many styles, for use on Electric Railway, Light and Power Circuits, both for Direct and Alternating Currents. They offer the discharge a path to earth of low resistance.

They also cut off the flow of normal current so that your circuits will not be grounded.

If you are interested we will mail you a pamphlet.

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BARE, RUBBER COVERED AND WEATHERPROOF WIRES AND CABLES
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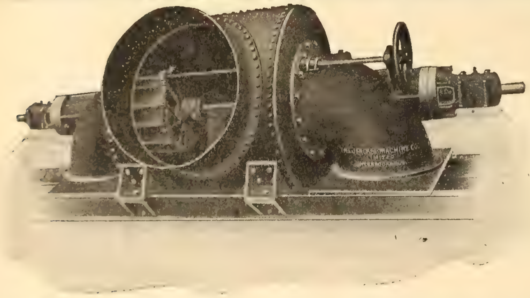

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meets the requirements of Electrical Work very fully. It is specially designed for speed, and is steady under variations of load. Its efficiency, under full and part gate opening, is equal to that of any other turbine now on the market. Special wheels are furnished for heads over 100 ft. Correspondence solicited. Estimates promptly furnished.

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CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XV. APRIL, 1905 No. 4.

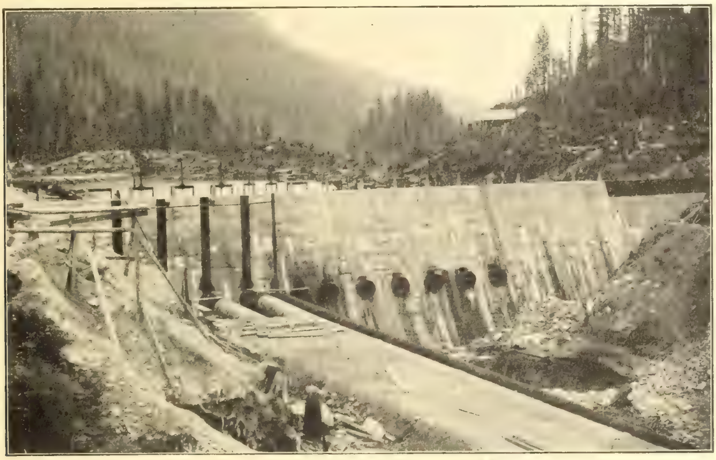
ELECTRIC POWER DEVELOPMENT IN BRITISH COLUMBIA.

One of the most important water-power developments for the generation and transmission of electric energy is now approaching completion at Coquitlam Lake, eighteen miles north-east of Vancouver, B.C. This enterprise was inaugurated in August, 1902, by the Vancouver Power Company, of Vancouver. The general manager of this company is Mr. J. M. Buntzen, to whom is due the credit of financing the undertaking. Mr. William Meredith is consulting engineer, the engineers in charge of the work being Messrs. E. B. Hermon and H. M. Burwell.

Coquitlam Lake, the main source of water supply, has an area of 2,300 acres and an altitude of 440 feet above sea level. The watershed to this lake is about 100 square miles. Trout Lake, the secondary source of supply, has an area of 500 acres and an altitude of 400 feet above sea level. A range of mountains 3,000 to 4,000 feet high separates these two lakes a distance of two and one-half miles.

Through this range of mountains a tunnel nine feet square has been driven, the contractors for this part of the work being Messrs. Ironside, Rannie & Campbell, of Vancouver. With the exception of the tunnel and the clearing of some of the land, all the work was done by day labor.

Work on the tunnel was proceeded with from both ends, the material to be cut through being granite. The total length of the tunnel is 12,775 feet or about two and a half miles. At the Coquitlam portal it was necessary to start the working tunnel above the lake level. This was run down on a grade of 6 per cent. until the finish tunnel grade was reached. The finish tunnel was afterwards constructed directly beneath this working tunnel, and steel gates placed in it. These gates are operated from the working tunnel above. Tram lines were built into the tunnel at both ends and the debris hauled out by electric motors. Ventilation was accomplished by means of a 12 inch galvanized iron pipe connected with two fans which served to extract the gases caused by the explosives. Fresh air was to a large extent supplied by exhaust from the air drills. In this manner exceptionally good air was maintained. Retiring stations for the workmen were provided 1,000 feet apart. The average rate of progress on this tunnel was fifteen feet per day.


VANCOUVER POWER COMPANY—DAM AT LAKE BEAUTIFUL.

Half a mile below the outlet of Trout Lake a concrete dam was constructed spanning a ravine. This dam is 361 feet long on the crest, and has a maximum height of 54 feet. By its construction an extra area of sixty acres has been flooded. Another dam of rock-filled timber construction has been placed at the outlet of Coquitlam Lake for the purpose of raising the level of the lake by 10 feet and creating storage.

Provision has been made for ten pipe lines to extend from this dam a distance of 1,800 feet to the power house. As yet only three of these pipe lines have been built and put in operation. The upper 800 feet of these pipes is constructed of wooden stave pipe 54 inches in diameter and the lower 1,000 feet of steel ranging from 48 to 42 inches diameter.

The power house, a stone structure on concrete foundation, 156 × 34 feet in size, is located at sea level, and is believed to be the only one in the world so placed. It has a capacity of four units of 3,000 h.p. each, of which there are at present three in operation.

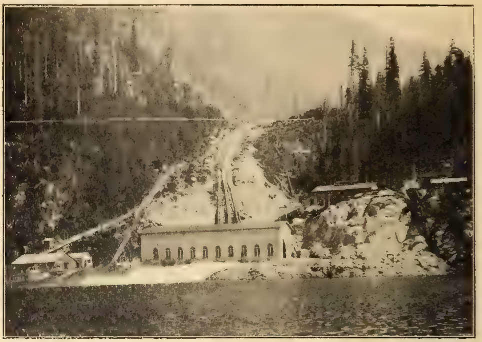
Vancouver Power Company—Portal, Trout Lake Tunnel.

The installation consists of Westinghouse generators and Pelton water wheels. Each unit consists of a generator set in the center of shaft with Pelton wheel on each end, the whole revolving on two bearings. This is said to be the initial use of this method, and the result has been most satisfactory.

The transformers are housed in a separate building, 42 × 68 feet in size, located about 100 feet from the power house and constructed entirely of concrete. From this point a double pole line extends along the shores of Trout Lake, crossing Burrard Inlet at Barnet, the span at this point being 2,750 feet. On the southerly side the cables are supported on two steel towers each 140 feet high. There are twelve steel insulated cables, the current being transmitted at a pressure of 20,000 volts.

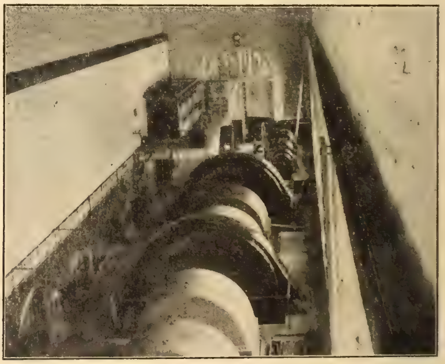
Vancouver Power Company—Heading Trout Lake, 6,000 Feet.

The tower anchors are supported on concrete piers. The anchorage is accomplished by separate anchorage towers. The strain for each cable comes on 28 insulators. These insulators are set in pairs. A cast iron cap is fitted over each insulator, and a steel yoke fits over each pair, being fastened on to the cable by means of a clip. Thus the strain comes first on the clips and is then transmitted to the yokes. The yokes are adjustable for the purpose of equalizing the strain in each pair of insulators.



Vancouver Power Company—Power House and Pipe Line, Lake Beautiful.

These works have been designed to give at ultimate highest capacity 30,000 h.p. The power developed will be used for lighting and power in the cities of Vancouver, New Westminster and neighboring municipalities, including the operation of electric railways in Vancouver, between Vancouver and New Westminster and the proposed new line between Vancouver and Steveston, a distance of seventeen miles.



Vancouver Power Company—Interior of Power House.

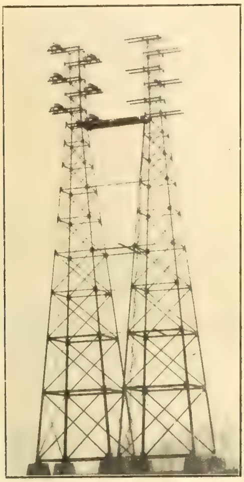
The Fessenden Wireless Telegraph Company of Canada has recently been incorporated.

The Stark Telephone Light & Power Company, of Toronto, held their annual meeting last month, when the former directors were re-elected. The president informed the shareholders that he had the authority of the directors to state that a dividend at the rats of 7 per cent. per annum would be declared in July on the preference stock of the company. The company intend erecting a new building at Toronto Junction.

CANADIAN ELECTRICAL ASSOCIATION.

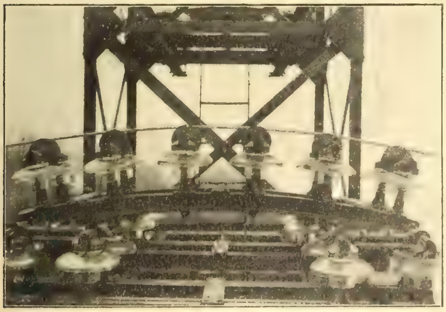
Satisfactory progress is being made by the various committees appointed to complete arrangements for the annual convention in Montreal. June 21st, 22nd and 23rd are the dates selected.

Electrically and in every other respect Montreal is an interesting city and, entirely apart from the interesting features of the convention, will well repay a visit.



Vancouver Power Company One of the Steel Towers.

A special effort is being made in preparing the programme to supply papers and subjects for discussion which should interest and benefit owners and operators of central stations and it will pay these to attend the meeting. A few dollars spent in meeting the people in one's own line of business and comparing notes and experiences with them, usually proves a good investment, and as it is pretty certain to be so in this case, every wide-awake central station man should resolve to be there.



Vancouver Power Company Top of Steel Tower, Showing Unique Construction of Cables.

A composite telephone system between Sherbrooke and Farnham, Que., has just been installed by the C. P. R.

Mr. Alex. Smith, who recently retired from the position of superintendent of the mechanical electrical department of the Toronto Railway, was presented by the members of that department with a purse of money and a very beautiful gold locket, with his monogram engrossed thereon. The presentation was made by Mr. W. Macrae.

AN 8,000 H. P. MOTOR-GENERATOR SET.

The great frequency changer at the Montreal substation of the Shawinigan Water and Power Company, of which we show a view on the following page, has peculiar claims to the attention of electrical engineers. It includes the largest motor ever constructed and the largest alternating current generator now in operation. The set completed the contract of Allis-Chalmers-Bullock, Limited, Montreal, for the installation of the machinery at the sub-station necessary to convert the alternating current transmitted from Shawinigan Falls 86 miles away, to meet the requirements of the city.

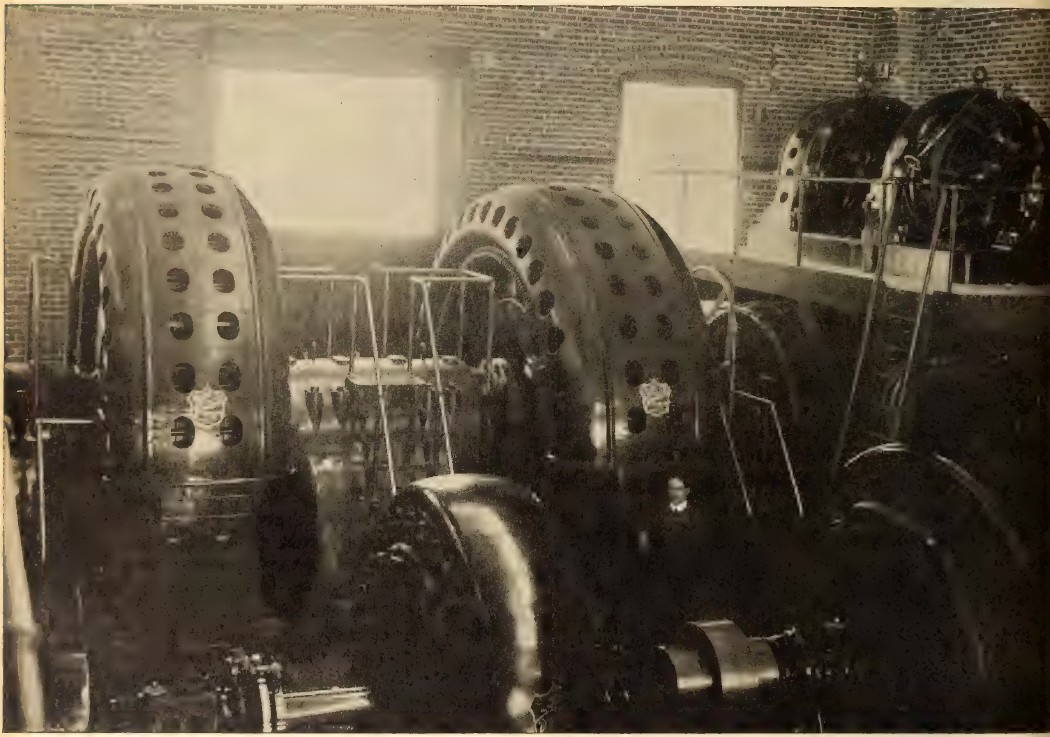
The current is generated at Shawinigan Falls at 2,200 volts, 30 cycles, and transmitted to Montreal over aluminum cables, the voltage being stepped up to 50,000. As the contract of the Shawinigan Company called for delivery of power in Montreal at 60 cycles, and as it was found more convenient to transmit it at 30 cycles, it was decided to change the frequency at Montreal by synchronous motor-generator sets. For this purpose the Shawinigan Company have erected a large terminal station at Montreal in which at present are installed five 1,200-h.p. frequency changers and one 8,000-h.p. frequency changer, built for the contractors by the Bullock Electric Manufacturing Company, Cincinnati. In addition there are two 800 k.w. rotary converters in connection with two 900 k.w. three phase transformers to supply direct current to the Montreal Street Railway, built by Allis-Chalmers-Bullock, Limited, Montreal.

The 8,000-h.p. synchronous motor-generator set consists of a 5,750-k.w. alternating-current generator, an 8,000-h.p. synchronous motor and a direct-connected induction motor for starting purposes, all mounted on the same base. The motor is capable of developing a maximum starting torque equivalent to 2,500 h.p. The total weight of this set is almost 500,000 pounds.

The armature yoke of the generator is made of cast iron, cast in halves, which are held in proper alignment by dowel pins and square splines, and securely bolted together. This casting is so cored as to allow the egress of an abundance of air for ventilation and still it is strong enough to form a rigid support for the armature. The yoke is built up of steel laminations .014 in. thick, which are punched simultaneously with the slots from specially annealed sheet steel. They are annealed after the punching in specially constructed furnaces and then japanned to prevent eddy currents. As a further prevention against the formation of eddy currents, tissue paper is placed between the punchings at intervals of ⅛ in. Throughout the steel core brass castings are spaced at frequent intervals, which provide for ample ventilation. The coils are firmly supported by a wooden block bolted to the stator yoke shields on each side, thus rigidly holding the coils in case of heavy short-circuits. They are held in place in the slots by seasoned hardwood wedges. The total weight of the stator is 80,708 pounds.

The construction of the rotor is one of extreme strength. Upon the spider, which is of cast steel, are built up the steel laminations 1/16 in. thick. At suitable intervals spacing blocks 2 in. wide are inserted for the purpose of thorough ventilation. Dove-tailed slots are stamped in the rim of these punchings for the reception of the poles, which are held in place by wedge-shaped steel keys. The poles, of which there are twenty-four, are also built up of soft sheet steel, held together by phosphor-bronze end plates, securely riveted. Each pole weighs 1,130 pounds and the complete rotor weighs 78,455 pounds.

The mechanical construction of the synchronous motor is quite similar to that of the generator, there being, however, only twelve poles, each weighing 2,200 pounds. The complete stator weighs 93,250 pounds, and the rotor complete weighs 80,595 pounds.



8,000 H. P. Frequency Changer Installed in Sub-Station of Shawinigan Water and Power Company, Montreal.

These machines are rigidly connected together by a coupling forged with two flanges, the flanges at either end of the shaft being securely bolted to the spiders of each of the above machines. The rotor of the induction motor is mounted on the extension of the synchronous motor shaft. The weight of the metal required for babbitting the three bushings was over 10,000 pounds.

The base is cast into four sections, viz., the two end sections for the main motor and generator, the middle section for the third bearing and a section for the induction motor. These separate parts are held in proper alignment by square keys and securely held together by shrink rings and bolts. The total weight of the base is 56,080 pounds.

This set was tested under full load conditions in the shops of the Bullock Company by the method originated by Mr. B. A. Behrend, chief engineer of the company.

In testing the generator, having twenty-four poles, the machine was connected so that twelve poles were in opposition to the other twelve poles. Half of these coils would then be acting as a generator and the other half a motor. The armature current would tend to magnetize the poles of the motor half and demagnetize the poles of the generator half, which would subject the machine to violent vibrations. In order to obtain magnetic balance each half is excited differently by placing a rheostat in series with each section and regulating the current. The C^2R loss is also accurately obtained in this manner, as full load current is made to circulate through the armature coils and also full load current is carried by half the number of poles. This unique frequency changer now in successful operation will make valuable additions to the existing data on alternating current machinery. The exciter for thi set is shown in the view elevated on a platform about 12 feet high, owing to the lack of space in the building. It consists of a 200 kw., 120 volt, direct current Bullock generator, which supplies direct current to the field of the frequency changer, directly connected to a 300 h.p. induction motor of 400 revolutions, the latter built in the shops of Allis-Chalmers-Bullock, Limited, at Montreal.

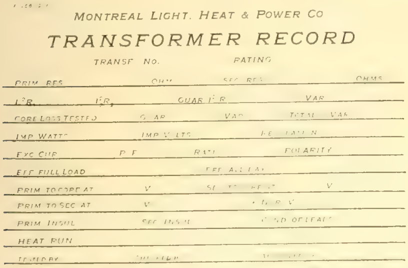
The People's Telegraph & Telephone Company, Limited, has recently been incorporated, with head office in the village of Maynooth, Ont., the object being to carry on a telegraph and telephone business within the county of Hastings. The promoters include Mr. W. J. Sergeant, banker, of Bancroft, and Mr. W. J. Fitzgerald, lumberman, of Maynooth.

CARE AND OPERATION OF TRANSFORMERS.

By M. A. Sammett.

The extensive use of alternating currents for ligthing purposes and the growing appreciation of their advantages as compared with direct current in the industrial application as a motive power, have made the alternating current transformer a very widely used apparatus. Every central station of any magnitude operates static transformers, whether the distribution in the business section of the city be by direct or alternating current. In a small city with a scattered load the alternating current appeals to the central station manager, in view of its better adaptability for reaching the customers at a smaller expense. In larger cities, where the business section consumes a considerable portion of the station's output by direct current distribution, the generation, transforming and transmitting of the power to the point of distribution are done frequently by alternating current, which is converted to direct current in a substation situated conveniently in that locality.

In view of the wide use of the static transforming apparatus, some suggestions as to the proper care and operation of both service and station transformers may be of interest. The good operation of transformers is often an inherent characteristic of the transformer proper, and depends altogether on the design of the apparatus. Given a good transformer, then if properly installed, connected to a load within the requirements of the guarantee and with proper precautions taken to protect the machine from lightning and static disturbances on the line and possible severe overloads, the transformer will remain in service and require no attention except for a systematic inspection, which should be kept up by every central station. This inspection should consist in an examination of the leads, transformer temperature and of the lightning arresters on the line. The benefit derived by both the station management and the public will more than repay the extra expense of instituting such an inspection. A defective lightning arrester will cause the burn out of a transformer. Transformer leads, exposed for a long period to the weather, are likely to become bare of insulation and come in contact with the case, grounding the high voltage on the low tension winding, and find its way into dwellings. Such possibilities of fatality that may cost customers their lives and the operating company expense for damages will be done away with under a rigid system of inspection. Safety of the customer should always be the watchword of those entrusted to some extent with the lives of the citizens and on this account no pains should be spared to fulfill the obligations to the public.


MONTREAL LIGHT. HEAT & POWER CO

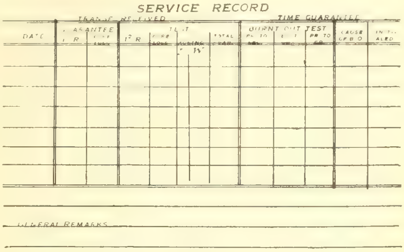
TRANSFORMER RECORD

TRANSF. NO. RATING

PRIM. RES. OHMS SEC. RES. OHMS
I²R. I²R. GUAR. I²R VAR
CORE LOSS TESTED GUAR VAR TOTAL VAR
IMP. WATTS IMP. VOLTS REGULATION
EXC. CUR. P. F. RATIO POLARITY
EFF. FULL LOAD EFF. ALL DAY
PRIM. TO CORE AT V SEC. TO CORE AT V
PRIM. TO SEC. AT V
PRIM. INSUL. SEC. INSUL. COND. OF LEADS
HEAT RUN
TESTED BY

Fig. 1—Front of Transformer Record Card.

Whenever changes are made on the line and transformers shifted from one locality to another, it is advisable that they should always be brought into the testing room, and no transformers should be allowed to be taken out unless they have an O K tag, indicating that the transformers had the required test and are in good condition for service. The testing department should keep a full record of all transformers. Herewith will be found a copy of transformer record card made up by the writer and used in the testing department of the Montreal Light, Heat and Power Company. If the transformer had a full test, the only additional tests necessary when transformers are returned to the station, are those of reliability of the insulation between the primary and secondary coils, as well as the insulation between the primary winding and core, and secondary winding and core. In addition to this, it is advisable to test for the exciting current and core loss at the operating voltage and normal frequency. This latter test will enable one to keep track of the changes in the magnetic properties of the core.


SERVICE RECORD

TRANSF. RECEIVED TIME GUARANTEE

DATE | GUARANTEE I²R, CORE LOSS | TEST I²R, CORE LOSS, EXCITING C. W., TOTAL GUAR. | BURNT OUT TEST PR. TO SEC., [illegible], PR. TO CO. | CAUSE OF B. O. | INSTALLED

GENERAL REMARKS

Fig. 2—Back of Transformer Record Card.

Next to the safety of the transformer, the question of its efficiency should be looked after. In some of the old type transformers the iron ages to such an extent as to make their further use detrimental to the economy of the station. The risk of a break down under such conditions of high temperatures is great, and out of consideration of safety and efficient operation such transformers should be removed. Some very interesting cases of abnormally high iron losses in transformers came under the writer's observation, and the following table contains a few of the figures:

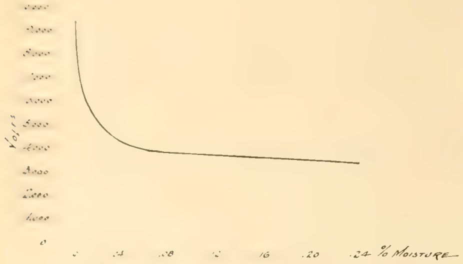
Capacity.	Exciting current in [illegible] of full load current.
½ K. W.	24.8
1 K. W.	28.2%
1 K. W.	19.5%
1 K. W.	16.5%
1½ K. W.	12.5
2½ K. W.	33.3%
2½ K. W.	23.6

This table hardly requires any comment. The figures do not call for any elaboration.

Taking up the consideration of the various types of transformers, we will subdivide them into several groups, classifying them as follows:

1. Dry, natural draught.
2. Oil insulated.
3. Oil insulated, water cooled.
4. Air blast.

Starting with the first mentioned--natural draught, dry transformer--it may be safely said that this type of apparatus is obsolete. It belongs to the pioneer class and has proved in service to lack some very important features. Of these the failure during lightning storms and static disturbances on the line, due to switching, are among the most serious objections to that type. Another consideration which is against the dry transformer is that it is of necessity a bulkier transformer for the same efficiency and consequently a more expensive apparatus, or for the same amount of material, and for same size, it will be a less efficient apparatus.



Curve of dielectric strength of oil

Fig. 3.

2. The transformer which is becoming the universal type is that of the oil insulated class. The oil serves a double purpose. In the first place, it acts as a cooling medium, carrying the heat away from the interior to the transformer tank, which dissipates the heat into the surrounding atmosphere, and in the second place takes care of static brush discharges, filling in the puncture made by these discharges and thus healing the defects caused by them. In view of the importance of oil as an insulating medium in transformers, it is essential that the oil should be of the best quality obtainable, and while every transformer manufacturer claims the oil he uses is the best on the market, the customer will do well by subjecting the oil to a dielectric test. From tests made on various samples of oil used by the numerous companies, all oils have about the same dielectric strength, but due to unforeseen conditions in shipment, the barrels being exposed to rain or snow, a certain amount of water and moisture may find their way into the barrel and greatly weaken the insulating properties of the oil. The testing department should try every barrel of oil used and if the disruptive voltage comes below a certain fixed value, the oil should be rejected. The di-electric test alone is sufficient, as it will always detect defective oil, whether the defect be due to moisture, water, acid or other foreign matter.

An adjustable spark gap immersed in a glass vessel and set for 1/8″ should withstand a pressure of 20,000 volts, and no oil should be allowed in transformers which will not stand the minimum disruptive voltage of 15,000 volts. The effect of moisture on the insulating properties of oil is shown in the curve above. Mr. C. E. Skinner, of the Westinghouse Electric & Manufacturing Company, has found, as shown in that curve, that as little as .06% of moisture will reduce the disruptive strength from 10,000 volts to 4,000 volts.

Whenever dry or oil transformers are kept indoors, some means should be provided for a free passage of air through the room. While it is essential under such circumstances to have the place fire-proof, an insufficiency of free air to carry away the heat given off by the transformer case will raise the transformer temperature considerably.

(3) As the oil insulated type of transformers is manufactured only in sizes up to 150 K. W., the larger units are provided with cooling devices having water circulated in pipes immersed in the oil. By this artificial means the size of the apparatus is kept down, as efficient means are provided for carrying away the heat dissipated in the iron and copper. This latter type of apparatus is becoming the standard type, especially in high voltage work.

(4) Whenever the voltages are not exceeding that of 25,000 volts, many consulting engineers prefer to specify air blast transformers, as in this case it is not essential to keep them in separate fire-proof compartments. Whenever the air blast type can be used, the lay out and wiring of the station is greatly simplified. In the last two types the successful operation of the apparatus depends on artificial cooling, and it is well to have duplicate means provided for the artificial cooling. So in the case of the oil-insulated water cooled transformers, means must be supplied by which a duplicate source of water circulation could be accessible. Using air blast transformers, two sets of motor blower units should be installed, both of them at the same end of the air chamber, so as to allow their operation at the same time whenever emergency may require. As a further safety in the case of oil-insulated transformers, special piping should be made by which, when the transformer is on fire, water could be admitted into the transformer at the bottom on the case, forcing the oil out through a pipe on the top of the case and into the sewer. Oil transformers should always be enclosed in separate fire-proof compartments, and means be provided by building an external case around it, by which the transformer could be immersed entirely in water, should it be threatened by an external fire as that of the building.

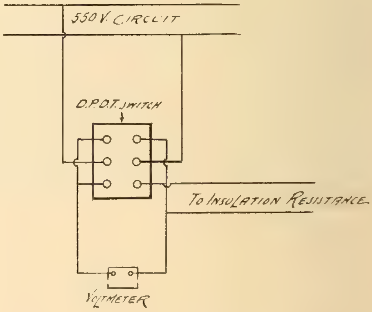


Fig. 4.—Connections for Insulation Test.

Another important feature in using water cooled transformers is that of having a guage which would be helpful in discovering any water that may settle down in the bottom of the transformer tank, through a defective water coil.

Automatic devices should be installed in the instance of the water cooled and air blast transformers which would enable the station operator to take immediate steps and disconnect the transformer with a leaky water pipe, or the spreading of fire from one air blast transformer to another. Signal bells can be wired so as to warn the station man of the approaching danger of the water settling in the transformer. Two leads placed close enough in the bottom of the glass guage when connected with a column of water will complete the circuit and ring an alarm bell. So with the air blast transformers, a gate should be placed underneath every unit and in case of fire the blast should be immediately shut off without interfering with the safe operation of any other unit in the same station.

Occasional trouble in water cooled transformers is attributed to leaving water in the pipes when the transformers are taken out of service. It is very important whenever the apparatus is disconnected that the water is completely removed, as otherwise in cold weather the water freezing is likely to burst the piping, and when connected to the water mains will become filled with water and cause the destruction of the winding.

If the presence of water is discovered in oil, the water and oil should be completely removed and the coils baked on a short circuit long enough to restore the insulation resistance to a safe point. New oil should be used preferably, but if this cannot be had conveniently without considerable delay, the water should be drained off and then the oil heated until all the moisture is driven out. In this connection it may be well to dwell more at length as to the method of drying out on a short circuit. The baking by external heat should be avoided and resorted to only when it is impossible to improvise means for electrical baking by the heat of the coils proper.

In transformers of larger capacity where the cooling is affected by either a blast of air or water circulation, the voltage necessary to force full load current through the coils will amount to approximately two per cent. of the full primary voltage. In smaller sizes the impedance voltage would vary from two to three and three and one-half per cent. of the full voltage. In the case of a 10,000 volt transformer, 200 volts applied to the high tension terminals will cause the flow of the normal current in both primary and secondary winding when the secondary winding is short circuited. It will be found, however, that the full load current will heat up the transformer too much, and if the temperature characteristics of the transformer are not known, lower voltages should be applied and a fraction of full load current used on a preliminary trial. The coils should be carefully watched and thermometer temperatures should not be allowed to pass beyond 90° C. The drying out should be continued until the insulation resistance has reached its maximum. The insulation resistance may be measured by the aid of a 600 D. C. voltmeter (see Fig. 4). Connect the transformer coils to the underground side of the direct current circuit in series with the voltmeter on one side of a D.P.D.T. switch, and right across the circuit on the other side the meter only. With constant impressed potential take two readings :

1st—Line voltoge—voltmeter only.

2nd—Voltage as read on meter used with insulation resistance in series.

Then using the following notation :

V = Line voltage.

v = Voltage reading when insulation is in series with meter.

Rm = Resistance of voltmeter.

Ri = Resistance of insulation.

The insulation resistance will be expressed as follows:

$$R\,i = \frac{R\,m\,(V - v)}{v}$$

It will be observed that the insulation resistance will be gradually increasing as the drying goes on, and will finally reach a point which will be the maximum resistance at the temperature at which the transformer is maintained, which should be kept uniform. Whenever transformers operate in parallel, it is absolutely necessary to verify that they will divide the load equally, if of the same capacity, or proportionally if of different capacity. Too great reliance in a manufacturer's claim as to what certain apparatus will do may lead to disastrous results, and a complete destruction of the station. Before transformers are multiplied their impedance should be determined and under no circumstances should transformers be used which will not divide the load within a few per cent. of the capacity of each transformer. Beside making sure of the impedance of transformers, they should be checked for ratio and polarity. The ratio of all transformers used in multiple should be correct within one-half per cent., as otherwise it will give rise to excessive circulating currents. The polarity of all transformers should be the same, as otherwise the transformer of reverse polarity will be short circuited on the rest of the transformer bank. Every station operating air blast transformers should have compressed air accessible for the purpose of blowing out the dust from the transformers, which should be done every other Sunday (the day of light load) if possible. The accumulation of dust is likely to lead to grounds and result in the burning out of the apparatus. Considerable precaution must be taken in using compressed air, as no moisture should be allowed to pass with the first rush of air from the tank. The air should always be permitted to discharge for some time before it is turned on the transformer. To minimize the amount of dust settling in the transformer, protecting screens in the air chamber will be of great benefit. For the safety of the operator all transformers kept within the station should have their cases well grounded, and for the safety of customers all secondary coils of service transformers should be grounded at the neutral point.

In conclusion it may be well to say that in three phase distribution it is good practice to use delta connected transformers in units of three for each group. The continuity of service is an important consideration, and whenever possible this arrangement should be adhered to. Should one of the units burn out, two-thirds of the load can be carried on the other two transformers, or the two transformers overloaded may carry the entire load for a short period until the defective transformer is replaced.

Besides securing continuity of operation, the delta connection is very desirable on account of not having the objectionable feature of the Y connections or T connections used in phase transformation. With the latter combinations an open circuit on one of the transformer secondaries under conditions of load is likely to be productive of highly destructive voltages resultant from the combined effect of the inductance of the open circuited transformer and the capacity of the line.

Mr. John Galt, C. E., of Toronto, has prepared plans for water-works, sewerage, and electric light systems to be constructed by the municipality of Indian Head, N.W.T. It is proposed to submit a by-law to the ratepayers to raise $140,000 for the purpose.

A NEW GENERATOR.

By William Asahel Johnson, Toronto, Canada,
(Inventor.)

The alternating current generator of the revolving field type herein described is considered by the writer and admitted by parties who have investigated and noticed the machine in operation to be a decided advance in dynamo design. The claim is made that this generator is superior in regulating qualities and in efficiency, and operates at a far lower temperature than generators of the old type. The type of revolving field adopted by the largest manufacturers in America and Europe is simply the multipolar field common to all commutating or direct current machines. Such construction has been the habit for the last fifteen years; during at least this period there have been brought out no designs having novelty or showing a new theory or principle of magnetic design. Aside from Tesla's motor, one is practically justified in saying there have been no new distinctive types of electric machines placed on the market during an even greater period, as the patents issued have covered mere details of design such as various devices for regulation, designs for laminating the frame or motor, etc., but no material or basic invention.

Fig. No. 1 gives an end view of this generator and shows also a short circuited winding which in this instance was used to give the machine self-starting ability when intended for use as a synchronous motor. That is, under light load the machine can be directly thrown on the line as an induction motor and when up to the speed the field can be excited and thereafter operate as a synchronous motor. This auxiliary winding would also be of use where two or more generators are run by separate engines and intended to be operated in parallel, as they would keep in synchronism better at any reasonable change in speed of the engine. This digression from the main question, i. e., the new field, readily admits of this special short-circuited winding and without very material increase in expense of construction. The writer desires to state, however, that such extra winding is not essential to his machine when used as a generator, but simply adds extra qualities when used as either a generator or synchronous motor, and such extra qualities are not so readily to be obtained in the other usual design mentioned in the first part of this article.

The new rotating field is shown in Fig. 2. The field may be mounted on horizontal or vertical shaft to suit the driving power. The radical and novel change in design will be readily seen by examining Fig. 3, which shows the old or usual type or revolving field. It can be readily seen that inasmuch as the function of the rotor (the field or primary) is first, to provide the magnetic field, and second, to vary the position of the magnetic flux flowing from the primary as relating to the armature (the secondary),—that the field electric (the copper winding) and magnetic (the iron) circuits are in a better balanced position as regards the inductive action taking place between field and armature than in any alternator yet designed. The magnet system of any generator controls the generation of the current, in fact, the magnet is the prime and essential feature of a generator, and yet the armature has been commonly looked upon as the chief point, and so common has been this habit that the armature has hitherto chiefly received the best thought and efforts of electrical people; but there is no getting over the fact, the magnet system in an electric machine is, and always will be, utterly indispensable, and the greater the perfection of its design and the stronger and more constant the flow of magnetic flux from its polar faces, the more efficient the generator and the more constant the electro-motive force generated, and all this depends upon the definite alignment of the magnetic poles by the establishment of an unchangeable neutral line that is a line of zero potential. Absolute regulation and a cool and efficient machine are the ends aimed at. The construction herein described achieves these desirable objects.

The regulation obtained is practically as close as in static transformers. Why? Because there is a definitely aligned and unchanging line of zero potential dividing the magnets and their inductive effect upon the armature, as absolutely unchangeable as the inequalities of the iron and the reversal of direction of flow in the armature circuits will admit of when using

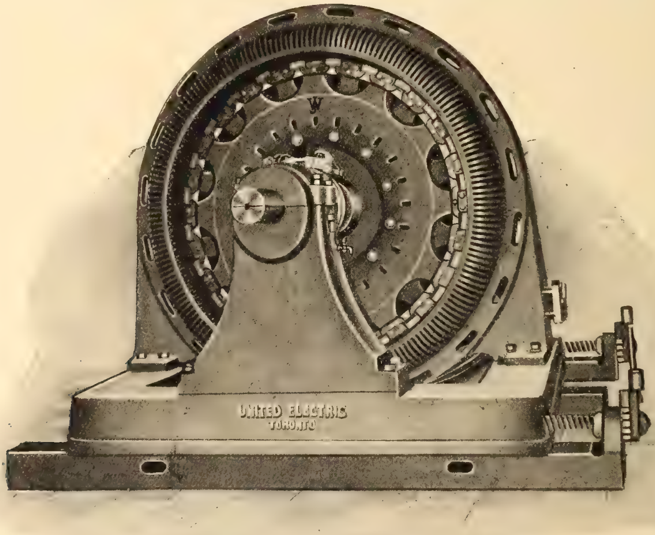


Fig. 1—New Revolving Field Alternator, W. A. Johnson Patent.

the common type of armature as used in the present construction. (The writer's patent claims, by the way, cover an armature construction carried out on identical lines to that of the field herein more particularly described). So perfect is the regulation that the circuits of the armature may be short circuited under full excitation of the field and the armature current not rise more than 10% above normal, or such other rise as may be pre-determined by the designer, whereas in the old type if the armature terminals are short circuited at much above one half full field, then the result is an over-heated machine up to the point of destruction under full field. It immediately becomes apparent that if a generator can be short circuited when generating its rated E. M. F., that is, under its normal field excitation, that the testing of the generator under full magnetic saturation will develop the maximum capacity of the generator, that is, such a test made at the factory establishes the normal and the overload capacity beyond dispute. Generators built under the writer's patents can be short circuited by means of oil switches under full voltage up to and even beyond 10,000 volts. The above circumstances of regulation indicate that armature reactions against full field need no longer prove a bug-bear, that induction motor loads can be handled in connection with lighting load with satisfactory results. By using the same construction in motors as used in the generator, but with the addition of the short circuited bar winding for self starting, these machines allow of the highest possible power factor under all load conditions. The generator or motors are interchangeable, i. e., the generator can be used as a commercial synchronous motor or generator at pleasure under the most favorable conditions. Again referring to Fig. 2, it will be noted that the field coils (of which only two are used regardless of the number of poles) are wound concentric with the shaft in the line of mechanical motion and therefore the mechanical placing of the coils is facilitated. The method of building up the rotor has been much simplified in later construction than as shown in cut. As now built, the field coils are very easily accessible.

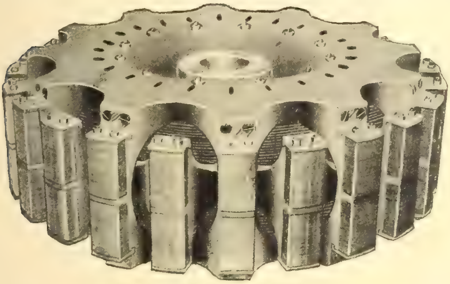


FIG. 2 NEW REVOLVING FIELD.

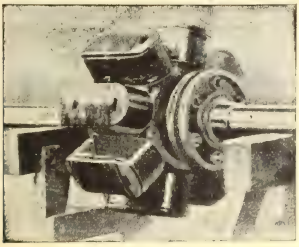


FIG. 3 OLD STYLE FIELD.

As above stated, the armature construction (see Fig. 4) as herein described is practically identical with other well known makes and is no better and no worse than theirs in any respect, using equally good material and workmanship.

As to temperature. The armature reactions common to the older types which necessarily cause counter action and again reaction and so on, in endless confusion between field and armature, are herein eliminated as in no other construction, consequently the temperature of the iron is extremely low, not 50% of the rise under similar conditions of size and output of other types, in fact, the heating of the entire machine inside the limits of carrying capacity of the copper and magnetic saturation and aside from the unavoidable eddy currents of the iron, can be considered as negligible.

The air gap between polar faces and armature iron may be as short as mechanical clearance may require and not so excessive as the older type. The efficiency is therefore very high.

At first thought it may be contended that the copper winding of the field might require to be heavier, but this is counter balanced by the decrease of the air gap and the peculiar qualities of the field which allows a heavier exciting current without corresponding increase in temperature for same capacity in the copper. The good regulating qualities of this machine do not end at the terminals, as it is a well known fact that all reactions within the generator are reflected in the circuits,and instead of a smooth current in the line the contrary is the usual case with the old type and the results are shown in the static discharge and broken down transformers.

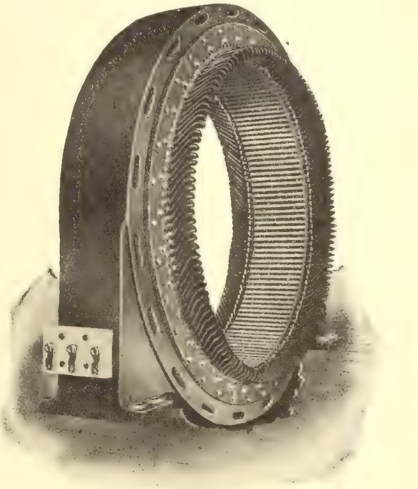


FIG. 4 ARMATURE.

The writer feels warranted in making the statement that it seems impossible to build an electric machine with more than two or less than two energizing coils and get the highest results, and as he has designed, built and been granted patents in various countries for inductor alternators and commutating machines embodying this same principle, he knows that the rule works not only both ways but three ways, that is, in the three commercial machines universally manufactured, the revolving field alternator, the inductor alternator,and the direct current multipolar dynamo.

As regulation means you can use efficient lamps, and on account of the economical generation of the current within the generator, the writer is prepared to undertake contracts for this construction with a guaranteed saving in operation to the purchaser of from 10 to 15 on the cost of generating plant.

These machines are manufactured in Canada by The United Electric Company, of Toronto; negotiations are under way for their manufacture and sale in the principal countries where patents have been granted to the writer.

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Electric Cooking and Heating.

So far as the invention of apparatus for utilizing for domestic purposes the heat generated by electric energy is concerned, the list today is almost complete, for a glance through any of the catalogues of the numerous manufacturers leaves practically nothing to be desired. The apparatus has long since passed the experimental stage, and at the present time it offers a method of culinary preparation which is both clean, quick, and highly efficient. Lest our use of the words "highly efficient" be misunderstood, we desire to explain that efficiency, when spoken of in connection with electric cooking apparatus, is based on comparisons between the amount of heat contained in the energy, and the amount which is actually taken up by the food. It is, one might say, an electrical efficiency. For instance, the ordinary kitchen range is the most inefficient cooking apparatus in our possession, for of the total heat in the fuel, but 2% is utilized by the food; of the balance, 12% is wasted in obtaining a glowing fire; 70% goes up the chimney; and 16% is radiated into the room. With a properly constructed electric oven, as high as 90% of the energy is taken up by the food. Referring to our editorial of last issue under the heading of "Conversion of Energy," we noted that the loss in converting coal into mechanical motion is very great If we figure the loss of all the items with the exception of that which occurs in the motors, or in other words, estimate the loss in converting the coal energy into electric current delivered by the transformers, we find that this electrical energy is 7.27% of the original. If an electric oven has an efficiency of 90%, then it will utilize a little more than 6½% of the energy in the fuel, and this contrasts very favorably with the ordinary cook-stove, where in spite of the fact that the fuel is burned direct, but 2% is used as already noted. If one means of cooking has an efficiency more than 300% greater than another, is it not worthy of consideration? But the difficulty of the matter lies in the fact that figures are deceptive—particularly those which we have given above. They are approximately correct as far as they go, and are to be valued accordingly, but beyond giving a comparison between the amount of fuel consumed with the two methods, absolutely no other item is taken into consideration. For example, let us figure the cost of heating a house by a coal furnace and by electric heaters. For simplicity consider that the first cost and maintenance of the two systems are the same, and then interest, depreciation and insurance can be left out. If one hundred pounds of coal be burned in the furnace per day, the cost of the fuel, at $6 per ton, is 30 cents. Add to this labor at 20 cents, and the total cost is found as 50 cents. Assume that the furnace has an efficiency of 50%, and then the amount of coal which actually is used in the heating is 50 pounds. The equivalent of this is 205 kilowatthours, and if the cost of current be 6 cents, the cost of heating for the day will be found to be $12.30 as against 50 cents for the other method. Electrical cooking and heating apparatus offers so much in the way of quickness and convenience that its high operating cost is often more than offset. When our water powers are more developed, and the cost of current is correspondingly reduced, we may feel reasonably sure that electricity will play an important part in the ordinary affairs of our everyday home life, and in the meantime, it is very satisfactory to note that the annual output of the apparatus is being steadily increased.

Street Lighting Questions. About this time of the year seems to be favored for the taking up and subsequent dropping of questions re municipal street lighting. Perhaps the men in whose hands the reins of government have just been placed feel it their duty to investigate such matters, but whatever the cause, the problems are often soon dropped, and very rightly. A plant from which energy for arcs and incandescents is charged to a municipality at cost, will certainly be the means of reducing the tax rate, but the great difficulty is to keep the operating cost of such a plant, when under civic control, as low as it would be when in the hands of a competent operating company. In any manufacturing business, and the production of electrical energy can certainly be classified under such a heading, the most careful management is required to make that business a paying one. Even a little carelessness will change the margin of profit into a serious loss, and considering this, surely it is not hard to understand why most municipal enterprises are failures. When the men, corresponding to the board of directors of a lighting company, are changed each year, and where they are elected without regard to their ability to handle electrical problems, it would seem almost sure that there could never be a profit from a manufacturing enterprise placed under their control. The municipal ownership idea may be all right, and a paying one, if the management of the plant be placed in the hands of a single competent man, and left there. But where politics enter into the situation, then the idea seems hopeless, because with each incoming council, there will always be at least one man who looks upon the executive ability of that body, and particularly of himself, as being something of an exceptional order, and of a superlative quality. And then the single competent man loses his position, all his good work is undone, and at the end of the year the next council is confronted with a deficit. In Toronto the question is being taken up, and a thorough investigation may result. It is doubtful, however, if the matter will ever come to anything, for the city has a very low rate per arc lamp per year, and the service is of the all-night, every-night order. New York is also in the throes of the same problem, and taking into consideration the fact that in New York there are more politics and pulls than in Toronto, it would be unwise to attempt to predict the outcome. The great difficulty in figuring the costs of such matters is that very few people appreciate the number of items which must be charged against the operation of a plant. In connection with the municipal plant of city of the Chicago, it was stated that the cost to the city per arc lamp per year was between fifty-four and fifty-six dollars. When an expert went into this statement, he found that the items of taxes, interest, and depreciation were not included, and showed that the addition of the excluded amounts brought the cost per lamp per year to just about double the sum previously mentioned. Following this matter, we have the fact that Chicago has recently contracted with a local company to supply six hundred arcs at a price of $103 for overhead wiring, and $136 for underground. In New York the existing prices are just a little higher than those which Chicago is now paying, though this is no doubt due to local conditions, and not to the demand of the supplying company for a larger profit. Taken all in all, the investigations have no bad effect, provided that the municipalities take no rash steps, and work under the advice and guidance of a competent expert. Then if that expert have had experience with municipal management, he will be in a position to advise his client of the exact probable operating cost. And when such figure is received, it will likely dampen the ardor which characterized the municipal movement at its inception.

Candlepower. That statements regarding the candlepower of different forms of lights are often misleading or even worse, has been asserted from time to time in the technical press of the United States and Canada. The rating of any form of light on a candlepower basis is permissible only when the distribution is uniform in all directions, and the only lamp which actually approaches the requirement is the incandescent, and it usually falls very far short. Putting a reflector behind a flame, or a lens in front of it, does not affect the total amount of light given out, though that thrown in one particular direction may be greatly increased, and may be proportionately greater as the distance grows, owing to the fact that the rays have been bent into parallelism. The rating of searchlights and other lights in which the distribution is affected by means of mirrors or lenses should be altogether abandoned, since it means nothing at all, although it may convey the impression that a light is exceedingly powerful or can be seen at a great distance. The old idea of calling an arc lamp "2000 candlepower" was long ago modified by introducing the term "nominal," though in latter years the candlepower rating has been eliminated almost entirely. Arc lamps are and should be rated on the energy consumption, and on no other basis. It is almost impossible to get a reading on an arc lamp by means of a photometer, for when the arc proper is on the side of the carbons nearest the instrument the light is very great, and when it wanders to the other side, in the intensity is greatly reduced. Incandescent lamps when under test are revolved very rapidly, and the candlepower is read on the horizontal. Standard lamps with the usual shape of filament will approximate sixteen units of light in this direction, while what is called the downward radiation may be but six to ten. The low consumption of energy per candlepower in lamps of the Nernst and Meridian types is due to the fact that most of the light is thrown downward by means of the arrangement of the light-radiating parts of the lamps, these being set below reflecting surfaces. Photometric measurement is based on the law that the intensity of illumination at any point varies inversely as the square of its distance from the source of light, and this law assumes that the light is allowed to distribute itself freely in all directions. When the distribution is altered in any way from what is considered standard, the candlepower rating should be accompanied by an explanation of how the measurement was taken. For instance, in a searchlight the beam is made to pass out from the lamp in one direction, and its rays are very nearly parallel. Suppose that a photometer is set up between a sixteen candlepower lamp and a searchlight, and that a balance is obtained with the screen one foot from the incandescent and one hundred feet from the projector. This would indicate that the light of the latter was 160,000 candlepower. Now, if the searchlight be moved away another hundred feet the intensity will not be much reduced, as the rays of of light are nearly parallel. Assume that it is not reduced at all, and then this second reading will indicate 640,000 candlepower. The absurdity of such a system of rating is evident, and manufacturers are showing their good sense by dropping it altogether and substituting an energy basis in its stead.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All queries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.

QUES. NO. 1.—How do you figure the internal resistance of a storage battery? Any ordinary resistance can be found with a voltmeter and ammeter by Ohm's Law, but the storage battery gives off voltage all the time, and I don't know how to measure it.

ANS.—If you have a storage battery, a voltmeter and ammeter will undoubtedly be part of your equipment. Measure very carefully the voltage of the battery on open circuit. Then connect a load across the battery terminals, with the ammeter in circuit. Read the amperes very carefully and at the same time get a reading on the voltmeter. It will be noticed that the second voltmeter reading is a little lower than the first. Then Ohm's Law holds good—R equals E over C. R being the internal resistance of the battery, C being the current shown by the ammeter, and E being the difference between the first and second voltmeter readings. Before this test is made the battery should not be either charged or discharged for some time, and the test readings should be taken as quickly as possible. This is to eliminate errors due to polarization.

QUES. NO. 2.—In view of the prevailing custom to ground the neutral of transformers, do you think the same idea could be applied successfully by grounding the armature winding of a three phase star connected generator at the centre point, using in the ground circuit a light fuse (depending on the voltage of the machine) of the enclosed type? In the event of a short circuit or heavy lightning discharge, would the winding be protected by such a scheme?

ANS.—Where the neutral of a transformer secondary is grounded this action is taken as a safeguard against the destruction of life. If a ground exist on one wire of the primary, and a breakdown occur in the transformer between the primary and secondary, then between the secondary circuits and the ground there will exist a difference of potential of almost equal the primary voltage, provided the neutral of the transformer be not grounded. If, however, the neutral be grounded the maximam voltage between any part of the secondary circuits and the ground will not exceed one half of the total secondary voltage. If, however, you ground the neutral point of the generator, it is true that the strain between any of the three wires and the ground is reduced something less than one-half, but that voltage will still be far above the dangerous point. We assume, of course, that your generator voltage is not less than 2,300. Therefore, as a safeguard, the idea would have no value—in fact, it would really increase the risk to the linemen. If a short circuit occur between two of the three wires, or even between all three of them, the ground connection with its fuse would not be in circuit. If a wire should come down, then a circuit is formed through the main fuses, and the ground fuse, and the blowing of either will break the short. In considering the advantage the scheme would have in connection with lightning discharges, it is difficult to say anything very definite. If the lightning arresters should fail to take care of the discharge, it is possible that it would pass on through the windings and go to the ground through the fuse, although the choke coil action of the generator winding might seriously impede such action. When the transmission is overhead, the scheme is seldom or ever used, as its advantage is doubtful and trouble may occur. Where underground distribution is used, with high voltages, the idea has been sometimes adopted, as it reduces the strain between the ground and the cables, transformers, etc. If it were to be considered at all, we think the fuse should be omitted entirely.

QUES. NO. 3.—(a) Explain in a practical way how lubricating oils should be tested that they may be selected for electric generators. (b) What is the difference between vacuum oil as used by pumps under pressure and other lubricating oils?

ANS.—(a) The chief requirements for an oil to be used in the bearings of generators are few in number and simple. There are many methods of making tests which can be used by the refineries, but which are unsuitable for use in the engine room. Perhaps the best and most effective test is to observe the oil under operation. If a bearing which has heretofore run cool and with very little oil, suddenly heats up when a change of lubricant is made, and the heating cannot be attributed to mechanical troubles, it is pretty safe to say that the difficulty lies in the oil. Dynamo oil should not have an appreciable evaporation when hot, nor should it thicken greatly when cold. If a thin film of the oil to be tested be spread on a sheet of glass, and exposed to the free action of air, evaporation may be easily noted. Oils of the vegetable class evaporate rapidly (comparatively speaking) and are therefore seldom suitable for use in generator bearings. Viscosity is another requirement. The best definition of this word is "stickiness." An oil may be very thin and yet have high viscosity. Pour a little oil on a sheet of glass and then hold the glass vertical. The bulk of the oil will run down and off at once if it be sufficiently thin, but a thin film will remain, and go off but slowly, depending upon the stickiness of the oil. The flashing point of oils used for lubricating bearings is comparatively high, and therefore it is seldom that a test of this feature is required. (b) The name "vacuum" is a trade-mark word applied to the product of the Vacuum Oil Company, which is a branch of the Standard Company. So far as we know there is no special treatment given this oil which merits the name vacuum, though constant use of the word has caused some confusion on this point. Practically any thin oil may be used for the purpose you mention, except possibly where some special requirement makes the use of a special oil necessary.

The report has been published during the past month that the New York Central Railway has secured control of the Buffalo Street Railway, the Niagara, St. Catharines and Toronto Railway, the Hamilton, Grimsby and Beamsville Railway, and the Hamilton Radial Railway, and that all the roads would be amalgamated. While it is probable that some negotiations of this nature are under way, it is not believed that a definite agreement has been reached.

WESTERN REPRESENTATIVES OF ELECTRICAL COMPANIES.

The rapid development of the Canadian Northwest is creating a large demand for electrical apparatus of all kinds. The municipalities of the West are progressive and desire modern methods of lighting, and in nearly all instances electricity is being adopted. The manufacturers of electrical machinery and supplies recognize the importance of this market, consequently we find as their western representatives men of exceptional activity and vigor and at the same time good business ability. We publish below the portraits and a few particulars of the Winnipeg representatives:

Mr. G. A. Powell.

Mr. G. A. Powell is the western manager for the Packard Electric Company, Limited, of St. Catharines, Ont., with offices at 31 Canada Life Building, Winnipeg. Mr. Powell has been associated with the company in various important positions since its inception some fourteen years ago, and is well known by the electrical fraternity in Eastern Canada. The territory now under his charge extends from Port Arthur to the Pacific Coast.

Mr. B. G. McBurney.

Mr. B. G. McBurney, who has recently been appointed Western Canada representative for the Canadian General Electric Company, was born near Toronto and has lived in Canada the greater part of his life. He entered the electrical field in 1889 as an employee of the Edison Electric Company, of Schenectady, N. Y. Later he went into the electrical contracting business, making a specialty of installing apparatus. He afterwards became the Ontario representative for the Walker Company, manufacturers of electrical apparatus, Cleveland, Ohio. Eight years ago he entered the Agency Department of the Canadian General Electric Company, being appointed their western manager about two months ago.

Mr. William E. Skinner.

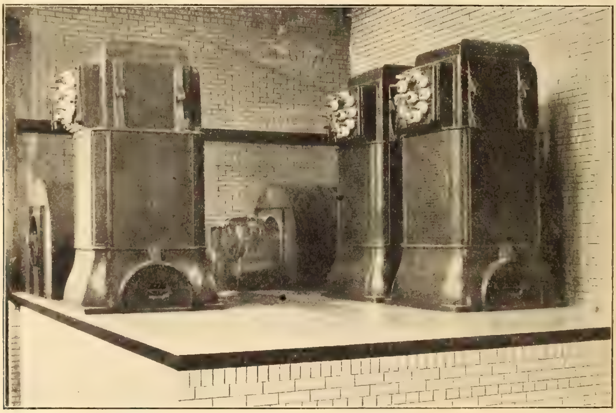
Mr. William E. Skinner, district manager and western representative of the Westinghouse Company for Manitoba, has his headquarters in the Union Bank Building, Winnipeg. He has been with the Westinghouse Company for thirteen years, having graduated in their shops at Cincinnati. Since then he has represented the company in Buffalo, Niagara Falls and Honolulu. From the warm climate of Hawaii he came through to the more vigorous climate of North-Western Canada. While in Hawaii Mr. Skinner was elected treasurer of the Honolulu Engineers' Association. He is an associate member of the American Institute of Electrical Engineers, is thirty-five years of age, and a splendid representative of the Westinghouse interests.

Mr. L. J. Belnap.

The western representative of Allis-Chalmers-Bullock, Limited, is Mr. L. J. Belnap, who has his headquarters at Winnipeg. Mr. Belnap has had a long engineering experience, both electrical and mechanical, having been connected with several large manufacturing companies. He has been on the expert construction staff and superintended the installation of some of the most important electric light and power plants in Canada which have been built by the Allis-Chalmers-Bullock. He was district engineer for the Company at Montreal and later engineer of the sales department at that city. In April, 1904, he was appointed district manager at Winnipeg.

AN OTTAWA INSTALLATION.

The Ottawa & Hull Power & Manufacturing Company are supplying power over their new 12,000 volt transmission line. Herewith we show an illustration of the step-up transformers, air chamber blowers, etc., designed and installed by their consulting engineer, Mr. R. S. Kelsch, of Montreal. The International Cement Company will take 3500 horse power to operate the new cement works, which are said to be the finest on this continent.



Step-Up Transformers, Air Chamber Blowers, Etc.—Ottawa & Hull Power Company.

A UNIQUE INSTALLATION.

By J. F. H. Wyse.

The plant recently installed by the Parisian Laundry Company at the corner of King and Portland streets, Toronto, has several features of interest which make it worthy of attention and of possible help, in the way of a model, for any company contemplating a like enterprise. The building is of white brick throughout, being 150 feet long by 66 feet wide, and fronting on King street, with four floors including the basement, amply supplied with windows and finished inside in white, so as to get absolutely the best lighting effects. The proprietors of this establishment, Mr. David and Mr. Robert Morton, seem to have appreciated the fact that white absorbs only about 15 per cent. of available light.

At the north side in the rear of the building is located the boiler and engine room and the generating plant. The boilers are of the tubular type, two in number and about 125 h.p. each, and are equipped with the latest smoke consumers of the simplex type. The engine is of the well known Wheelock design. This part of the plant was built and installed complete by the Goldie & McCulloch Company, of Galt.

All of the laundry machinery, which is used in connection with an amount of water, is located in the basement over drains in the concrete floor connecting directly with the city sewerage system, and is driven by counter shafting belted to the engine. The Turnbull elevator, connecting the four floors, is driven in the same manner.

The electric plant consists of two 17½ k.w. direct current, belt driven generators, 1175 r.p.m. and wound for 250 volts. The connections are so arranged at the switchboard that they may be operated either together in multiple, on both the lighting and power circuits, or separately on both, or either machine may be worked separately on either lighting or power circuit. These machines with switchboard and a 5 horse power motor, operating a line shaft for dryers and starchers, were furnished by the Canadian General Electric Company. The wiring, contract for which was let to Messrs. H. F. Strickland & Company, of Toronto, is laid out for one per cent. drop. The lighting circuit consists of two No. 4 B. & S. stranded R. C. cables in Richmondt conduit, distributing from blue Vermont marble panels to four branch mains of No. 8 B. & S. R. C. stranded cables, also in Richmondt conduit, on each floor, and to 220 volt 32 c.p. lamps, arranged on the ceiling with 12″ mirror reflectors. The power circuit consists of two No. 2 B. & S. R. C. stranded cables connecting through iron junction boxes with No. 6 B. & S. branch mains, run on the under side of each floor, through which they rise, all in Richmondt conduit, to individual motors. All conduits are furnished with water tight joints, and hermetically sealed.

With the exception of the washing machines in the basement, every separate machine is driven by an individual motor, geared directly to suit the speed of that particular machine.

When this individual drive was at first contemplated, Mr. Morton insisted that the motors must all be geared to do away entirely, or as far as possible, with dust or anything like belts that might accumulate or convey dust. When the speeds of these machines were consulted with relation to the amount of power required, we found there were four sleeve band ironers taking only ⅛ of a horse power each, and working at 72 r.p.m.; two mangles taking two h.p. each at 85 to 300 r.p.m.; a yoke ironer at ⅛ horse power and 90 r.p.m., and so on, covering in all some thirty small motors required, of low and variable speeds.

Careful inquiry among manufacturers of standard electric apparatus seemed to reveal nothing that would meet the requirements. In the United States we found where several of the large electric manufacturers had attempted with failure the equipment of laundry machines, and it looked very much as though the project would have to be abandoned, or special motors in each case designed with their different control as to speeds, and special gears. A few figures in connection with tee mechanical features of this proposition convinced us that it would run into entirely too much money, and it was abandoned. Shortly after this we found The Mechanical Appliance Company, of Milwaukee, Wis., had equipped some similar machines in the United States with Watson motors. Further inquiry convinced us that these motors were giving satisfaction and the contract was awarded the Mechanical Appliance Company. These motors are wound for 220 volts and in almost every instance the machines are self-contained, the motor being mounted either on the base or frame of the machine.

This plant illustrates how the tremendous loss of distribution by shafting may be saved, and how laundry work is done on a large scale, and in a most up-to-date way, and besides has the distinguishing feature of being the first and at present the only plant of the kind in Canada.

A LARGE INDUCTION REGULATOR.

The Montreal Light, Heat & Power Company have installed in their Maisonneuve substation an immense induction regulator, which is shown herewith. It is believed to be the largest piece of apparatus of the kind in the world. The regulator has a capacity of 5000 amperes at 2400 volts, designed to raise or lower the pressure 10%. The regulator will be used in connection with the permanent plans of consolidating the Montreal Light, Heat & Power Company's two phase 66 cycle system with the Lachine Rapids Hydraulic & Land Company's 60 cycle three-phase system, which plans have been designed by and are being carried out under the supervision of Mr. R. S. Kelsch, the company's consulting engineer.

Induction Regulator Installed in Montreal Light, Heat and Power Company's Sub-Station.

At a meeting of the Engineers' Club of Toronto, held on March 23rd, Mr. K. L. Aitken, consulting engineer, presented a paper entitled "The Relation between High Tension Lines and Other Lines." A large number of members were present, and the paper was followed by an interesting discussion.

THE LATE LEONARD E. DYE.

The Winnipeg electrical world recently sustained a loss in the death of Mr. Leonard E. Dye, which occurred on Sunday, March 19th. Deceased had been living in Winnipeg since 1900, when he took charge of the electrical work of the E. S. Harrison Company, Limited. Prior to that time he was in the employ of the General-Electric Company at Minneapolis, as expert in charge of their arc lamp department. In February, 1904, Mr. Dye left the Harrison Company and started the Winnipeg Electric Company, but later severed his connection with that concern to accept a position with the Hudson Electrical Supply Company of Winnipeg, which he held up to the time of his death. He was only 34 years of age, but was recognized as one of the best electrical engineers in the city and was instructor at the electrical engineering classes conducted at the Y.M.C.A. The students of his class acted as pall bearers and his fellow employees at the Hudson Electrical Supply Company followed the funeral.

WINNIPEG POWER DEVELOPMENTS.

The Winnipeg Street Railway Company are pushing forward to completion their water power development works at Lac du Bonnet and it is expected that electric power, generated at these works, will be transmitted and put to use in Winnipeg before the close of the present year.

Another company has been organized to utilize this water power, and it is said that this company have sold debentures to the amount of one million dollars for this purpose, and that as soon as these debentures are printed and signed the scheme will be proceeded with. The citizens of Winnipeg feel that one of the greatest needs of the city at the present time is cheaper fuel for manufacturing purposes, the present cost of fuel being almost prohibitive. If the scheme undertaken by the Dominion Government a year or two ago for the improvement of the Winnipeg River is carried out, it will place at the disposal of the citizens of Winnipeg a plentiful supply of wood for fuel and building purposes, from Lake Winnipeg, which under present conditions can only be obtained for a very short time each year, during the period of high water.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

The annual convention of the Canadian Association of Stationary Engineers will be held in the city of Chatham, Ont., August 22nd, 1905, and it is expected that the attendance will be larger than usual, as the question of legislation will likely be discussed at some length. The engineers have prepared a bill, to come up at the present session of the Ontario Legislature, to regulate the qualifications of engineers in charge of steam plants. They desire that every engineer operating aplant of 25 h. p. or upwards should be compelled to hold a duly certified certificate from a board of examiners, consisting of at least three qualified persons, appointed on the recommendation of the Minister of Agriculture. The need of some legislation along this line is very apparent. During the past two years there have been 21 boiler explosions in the province of Ontario alone, by which over thirty persons were killed or wounded. On marine engines, which are under Dominion Government supervision, there has been but one explosion in 23 years.

At a recent meeting of the Stationary Engineers' Association, Victoria, B.C., an interesting paper on "Vacuum" was read by Mr. M. Hutchison.

Messrs. P. E. Marchand & Company, 128 Sparks Street Ottawa, are installing an electric plant at Papineauville, Que. The power will be transmitted 15 miles for lighting the villages of Papineauville, Montebello, St. Andre Evelin, and Thurso. They are putting in a 150 k.w. generator and expect the plant to be in running order by June 1st. In the course of a year or two they expect to extend the plant to take supply several neighboring towns. The same parties are installing a plant at Maniwaki, where they are putting in a 250 k. w. generator, three-phase five miles transmission, to be completed by the first of October There is a fine water power there and it is intended to furnish light and power to several municipalities in the district.

JANDUS SERIES ALTERNATING ARC LIGHTING SYSTEM.

The Jandus Electric Company, Cleveland, Ohio, manufacturers of enclosed arc lamps,have put upon the market a new system of series alternating arc lighting, which has several features of great interest.

The illustrations show the arc lamp, the regulator and a special arrangement of regulator and switchboard panel. These and many details relating to the system are described and illustrated in Bulletin No. 21, issued by the company.

The lamp, Fig. 1, is of the widely known Jandus interchangeable type, the casing, glassware and main body being identical with Jandus lamps for all the classes of service now in use, both alternating and direct current, the integrally mounted mechanisms being interchangeable. The interchangeable feature is obviously of great value to central stations using a variety of circuits, as all lamps may be uniform in appearance and structure, with the same inner globes and carbons, and all repair parts identical excepting those forming part of the interchanged actuating mechanisms. The lamp has a differential mechanism, and the regulation claimed for it is very fine. All details are worked out with the same skill and care that have characterized the work of the Jandus Company in past years. This lamp won the highest award (gold medal) at the World's Fair at St. Louis. The long burning life of the lamp—140-175 hours—is specially notable.

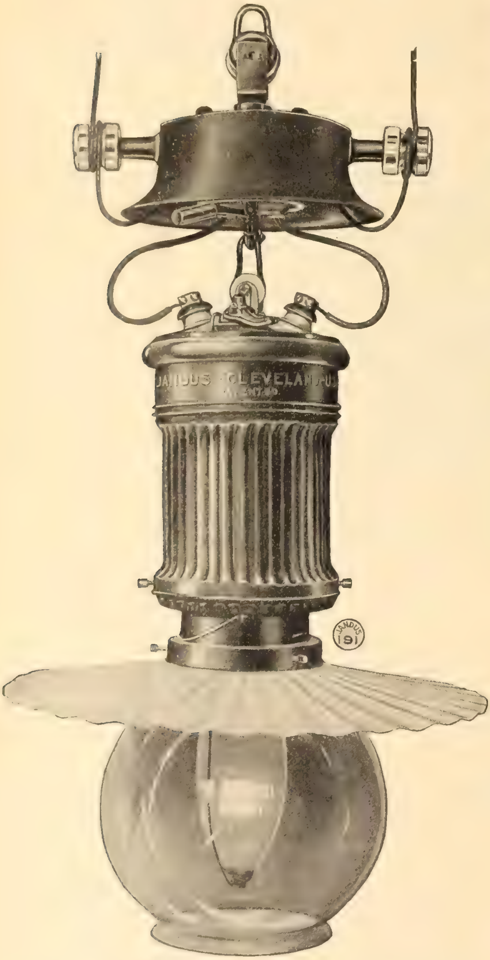


FIG. 1.—JANDUS SERIES ALTERNATING CURRENT ARC LAMP.

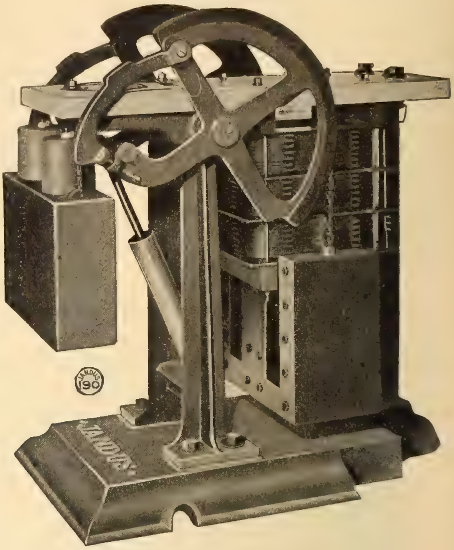


FIG. 2.—JANDUS SERIES ALTERNATING CURRENT REGULATOR.

The regulator, Fig. 2, is perhaps the most interesting feature of the system. It is of the inductive type and is designed on novel lines. It consists of a baseplate and a vertical frame upon which is mounted a heavy marble top. This top carries the terminal binding-posts and supports the inductive coil. The purpose of this construction is to insulate all the current-carrying parts thoroughly from ground. The coil is stationary so that no flexible leads are required. The core is movably mounted to operate vertically into and out of the stationary coil. A weight is connected to the movable core by means of steel chains located in grooved wheels which are mounted on finely finished ball bearings. The weight serves to counterbalance the core when the coil is not energized. Through the medium of an adjustable cam on the counterweight side of this system of forces the moment is made inversely proportional to the magnetic force which actuates the core. The coil is constructed of fire and moisture-proof wire and the insulating heads are of mica, so that the regulator will withstand a short-circuit for an indefinite period.

Fig. 3 illustrates a special feature of the Jandus system whereby the regulator and switchboard panel are installed as a unit, which of course may be multiplied in the central station. This arrangement saves largely in floor space, but its particular advantage consists in compacting all the apparatus necessary to be observed and manipulated and in installing it within reach of the attendant. In such an installation the operator has before him and within reach every part of the regulator and every switchboard instrument, so that without changing his position he can make all necessary observations and adjustments in starting the circuit.

The following claims are made as to the advantages of the Jandus type regulator:

Current-carrying parts suspended from marble and thus thoroughly divorced from ground; elimination of frictional retardations by use of perfect ball bearings; fixed coil and movable core, this arrangement requiring no flexible connections which are frequent sources of annoyance; disposition of the counterbalancing weight within the parallelogram of the base, this saving floor space and eliminating the projecting arm, which is often in the way of the station operator; harmony of design with switchboard panel, permitting the installation of the regulator and switchboard as a unit; an indestructible coil capable of withstanding a short-circuit indefinitely.

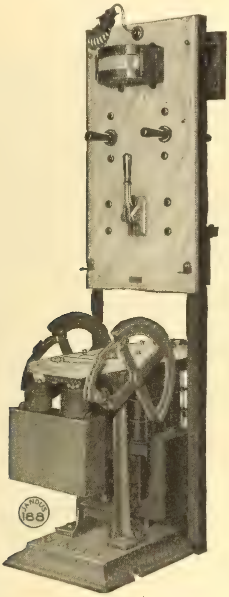


FIG. 3—JANDUS REGULATOR AND SWITCHBOARD PANEL INSTALLED AS A UNIT.

The Packard Electric Company, St. Catharines, Ont., are the Canadian representatives of the Jandus Electric Company and will be glad to furnish any further particulars desired regarding this new lighting system.

GERMAN REGULATIONS FOR HIGH-TENSION OVERHEAD WIRES.

The regulations of the Verband Deutscher Elektrotechniker as amended last year include a number of rules for high-tension overhead wires and cables, the chief points in which we give briefly below :—

All installations come within the range of the high-tension regulations, if the effective pressure between any conductor and earth is (or may be through an earth) more than 250 volts.

Overhead wires must be bare, but where they are exposed to detrimental chemical action they may be provided with a coating of protective paint.

The insulation of overhead wires in damp weather must not be less than 80 ohms per volt and kilometre (128 ohms per volt and mile) but need not exceed 1,500,000 ohms. Generating plants are to be provided with means for measuring the insulation resistance during actual service.

Overhead wires must have a cross-section of not less than 10 sq. mm. (0·0155 sq. in.).

The insulators must be of porcelain, glass or an equivalent material, and, when used for voltages above 2,000 volts, they are to be tested at the factory to at least double the working voltage. The insulators are to be used in an upright position only.

Earth connections are to be soldered, the only exception being when earthing switches are used, in which case the connections may be screwed to the switch and the object to be earthed. Wire netting, perforated or unperforated metal sheets, or similar materials are to be used as earth plates, and pipework may form part of the earth connection, but must be supplemented by such earth plates.

Supports and guarding devices of overhead conductors, the voltage of which to earth exceeds 500 volts, must be marked by a red zig-zag.

Overhead wires must be at least 6 metres (20ft.) above the ground in ordinary positions and at least 7 metres (23ft.) when crossing highways. The span and sag of overhead wires are to be such that the factor of safety against breaking is 10 in the case of wooden poles, and 5 in the case of iron structures. At—20°C. (—4°F.) the tensile stress in the overhead conductors must not be more than one-fifth (or one-third in the case of hard-drawn metal) of the breaking stress.

Overhead wires and apparatus must be inaccessible without special means.

In inhabited places the overhead wires must be provided with section switches which may be operated during actual service.

In inhabited places and grounds and in the proximity of roads, where falling wires might endanger life, the wires are either to be placed so high that, upon breakage, the wire ends hang not less than 3 metres (10ft.) above the ground, or the falling of the wires must be prevented by guards, or means must be provided for causing the fallen parts to become "dead." Provision is to be made at corners of the transmission line for preventing the wires from dropping should the insulators break.

Where the pressure exceeds 1,000 volts, the anchor wires are to be fixed to the poles with the interposition of an insulator, and the point of attachment to the pole must not be less than 3 metres (10ft.) above ground.

If iron poles are used which cannot be well earthed, the pole is to be surrounded (but not touched) by wood or a material having similar insulating properties, to a height of 2 metres (6½ft.) The earth conductor of the lightning rod must be treated in a similar way.

Where the wires run along the outside of buildings, the distance per 1,000 volts between wall and wire must not be less than 1cm. (0·4in.). The total distance must be at least 10cm. (4in.).

H. W. Beveridge, of Andover, N.B., James Burgess, of Grand Falls, N.B., and others, have been incorporated as the Provincial Telephone Company, Limited, to construct and operate telephone lines in the counties of Madawaska, Victoria, Carleton, York, Restigouche and Northumberland, N. B. The proposed capital stock is $10,000.

TELEGRAPH and TELEPHONE

THE INDEPENDENT TELEPHONE SYSTEM AT NEEPAWA, MANITOBA.

There have been established up to the present time but very few independent telephone systems in Canada. The first municipality to enter the field against the Bell Company, to successfully maintain a public service system, is the Town of Neepawa, Manitoba. This town has, at the present time, about 1,600 inhabitants and is in one of the most prosperous and rapidly growing agricultural sections of the Dominion, about 100 miles west of Winnipeg. The decision to establish a municipal telephone system was reached as far back as 1899.

The committee having the establishment of the exchange in charge, aimed to fix the basis of service rentals upon a purely maintenance basis. This was done so that the subscriber of the system would not be required to pay into the city treasury to the benefit of the non-user, but that they might pay a sufficient rate so that the rate-payers of the town who did not use the system would not be required to bear any of the expense or responsibility of the system. A charge of $12 per annum for domestic service and $24 per annum for business use was decided upon.

While the exchange started with but a small number of patrons, tbe municipality equipped the central office with a capacity for 150 lines, intending to provide for all future demands. The reasonable rentals charged soon resulted in a large increase in the number of subscribers. About a year ago the demand for the service from new subscribers far exceeded the capacity of the plant, and in order to accommodate the requirements it was necessary to greatly extend the system and enlarge the plant.

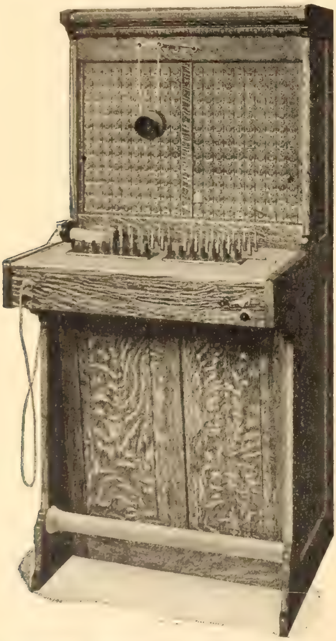


Fig 1—Neepawa Telephone Exchange—Front View of 200-Line Section of Switchboard.

When the exchange was first installed, it was equipped with a manual restoring drop switchboard with shutters for indicating to the central the subscriber's call, and with the subscribers' instruments of the individual generator-call and local battery type, of a French manufacture.

Under the great development of telephone systems during recent years, the apparatus as originally installed at Neepawa was of a very antiquated type as compared with present systems. To give its patrons the most convenient and reliable service obtainable, the Municipal Council, on April 29th last, decided to not onty enlarge the service, but also at the same time to thoroughly modernize its plant by putting in a full central energy system, so that the subscribers might signal the central office automatically by taking the receiver off the hook, and so that the disconnect signal would be automatically given when hanging up the receiver, and also so that there would be no batteries at the subscribers' telephones, but having all the batteries located at the central office.

The day after the council had passed the resolution for modernizing and enlarging the system, the town unfortunately sustained a severe loss through a heavy flood destroying one of their water-power dams, which it was necessary to replace at once. With this unexpected expense, the town was required to reduce all other appropriations, including a reduction of the telepeone appropriation, to such an amount that it would be impossible to entirely re-equip the system as well as extend the service.

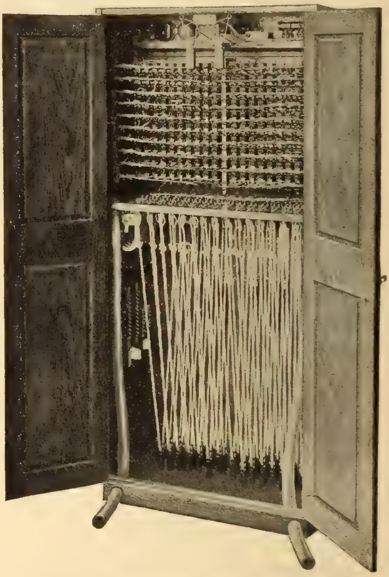


Fig. 2—Neepawa Telephone Exchange—Rear Interior View of Switchboard.

It was absolutely necessary, however, in order to meet the pressing demands for service, that the system be extended at once, which necessitated increasing the central office apparatus as well as increasing the number of outside lines.

Apparatus of all the principal makes of European manufacture and all of the independent manufacturers of the States were thoroughly investigated, and tenders, with samples of the apparatus proposed, were called for. After a careful comparison by their electrical engineer of all of the samples of equipment submitted, and a consideration of the tenders submitted, the contract was awarded the International Telephone Manufacturing Company, of Chicago, including the rebuilding of the outside construction and also including the erection of a large quantity of lead-covered cable and terminal boxes.

The system proposed by the International Company was especially adapted for the peculiar situation there, as it enabled the municipality to make provision in the equipment installed at this time so that it will be necessary only to re-equip the central office and allow the equipment to be changed to the central energy system at any time in the future, without discarding any of the apparatus installed at this time.

This is a system entirely new in the telephone field and a brief description will be of interest to those contemplating the re-equipping of old exchanges or the building of new plants where it is impossible to install an entire central energy system at first, but where, in time, it may be desirable to change to central energy.

Fig. 1 shows the front view of a 200 line section of "International" self-restoring drop switchboard. The drop is of the tubular type, constructed of a magnet coil with fine silk-covered magnet wire wound over a soft iron core, with the spool encased in a soft iron tube to eliminate entirely all cross-talk or induction between the lines in the switchboard.

The drop armature is pivoted on the rear of the drop and is provided with a long pin forming a latch through the shutter at the front of the board, so that at the slightest impulse of the generator at the subscriber's instrument, the shutter is unlatched and indicates the call. A small trigger is placed in the spring jack in the path of the plug, and so arranged that when the plug is inserted into the jack, the trigger automatically restores the drop shutter. The restoring trigger is mounted on a heavy German silver compensating spring so as to make the restoration of the shutter positive at all times, even after long-continued usage. These combined drops and jacks are mounted in rows of ten, on heavy steel strips properly insulated with mica sheet and hard rubber screw bushings.

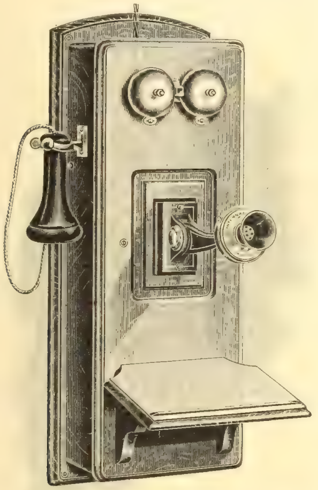


FIG. 3—NEEPAWA TELEPHONE EXCHANGE—LONG DISTANCE WALL TELEPHONE.

The line equipments are held in position on the strip by the ferrule of the jack which screws into the jack base, firmly clamping these parts. These line equipments may be readily removed with a friction wrench placed in the jack ferrule on the front of the board. In this way the jack ferrules may also be readily removed and replaced, if necessary, after becoming worn from long-continued usage. The strips of ten line equipments are each mounted on the front of the board on a heavy steel frame, properly braced to make the board strong and rigid. The clearing-out drops or "disconnect" signals are placed in the bottom row and immediately above the cord circuits.

The board is equipped with fifteen pair connecting appliances, each pair consisting of a ringing and listening key with ring-back key, a pair of plugs, cords, pulley weights, cord terminals and necessary wiring. The plug shelf is covered with heavy belt leather to provide a cushion for the plugs when returned after disconnection, and also to prevent the top of the board from being marred by the continual impact of the plugs. The plugs are compact, but are of sufficient size to enable making every part strong and durable. Each plug is provided with an insulating sleeve so mounted that it will turn the plug body, so that when the operator twists the plug when inserting into the jack, it will not break and kink the connecting cord, which greatly reduces the strain on these parts.

The combination ringing and listening keys and ring-back key are compactly mounted upon one base. The long key, shown toward the front of the board, is a regular ringing and listening cam. It is so connected that when an operator inserts a plug into any of the subscribers' line jacks and presses the corresponding cam toward the board, it throws in and connects the operator's instrument with that particular line. After the mate plug is inserted into the line jack of the subscriber wanted, and the key is pulled toward the operator, it cuts in the generator and rings the subscriber's bell. When the key is in the ringing position, it is automatically restored when the operator releases the pressure on the cam. The key may, however, be locked in the listening position so that an operator can carry on a long conversation with a subscriber, if necessary, without holding the key in position.

When it is desired to ring back on the line originating the call, the small button back of the regular ringing cam is pressed toward the board, which throws the generator on the answering cord. This combination key is so constructed that it requires but one set of main ringing springs, making two less springs and four less contacts than any other key of its kind now in use. The keys are provided with long and heavy springs, punched from the highest quality spring German silver sheet. The springs are provided with genuine platinum contacts.

Fig. 2 shows an interior view of the rear of the switchboard, showing the wiring of the line equipments, the night bell, the operator's instrument induction coil, the central energy coil, the cord circuits, etc. As constructed and used at the present time, it is for generator-call and local battery system. At the top of the board, between the night bell and induction coil on the central energy coil, is shown a card reading "Take short off this coil for central energy." This is the only work required for changing this switchboard from a magneto-call local battery system to a complete central energy apparatus, in addition to connecting the central energy wires at the line equipments, which are provided with screw terminal wire clips so that the change may be readily made.

This system enables the municipality to temporarily use their old individul generator-call and local battery instruments and at any time in the future, when it is deemed advisable to change to central energy, they can alter the system without discarding any of the apparatus of the new style installed, but by simply adding the central office battery plant and replacing the old instruments with central energy telephones.

Fig. 3 shows the long distance wall instrument of the "International" type that are being installed in the increase of the system and for replacing the old apparatus as required. These telephones are equipped with a granular carbon type transmitter with a very fine and reliable adjustment so they may be adjusted sensitive for quiet office and residence use, and slightly deadened for machine shops or other noisy places. The receivers are of the horse-shoe magnet bi-polar type, with all of the metal parts self-contained and entirely enclosed in a hard rubber shell and cap, no parts of the receiver depending on the shell for holding the adjustment.

The transmitter arm is of the long extension type, arranged so that the transmitter may be raised or lowered to suit the convenience of the user. The base of the transmitter arm is provided with a sub-base which is permanently mounted on the wood-work and supports the connecting clips and the wiring of the arm, and holds the transmitter arm in place by means of two heavily nickle-plated machine screws, which avoids unscrewing the base from the backboard when inspecting the instrument.

The transmitter circuit is taken directly from the front and back electrode of the transmitter, through insulated conductor cord, direct into the instrument to the induction coil, thus avoiding using any part of the transmitter or arm for completing one side of the circuit.

The generators are strongly constructed and very powerful in their action, insuring the indicating of the central office signal at every call upon properly constructed lines. The generator is provided with an automatic shunt so that it is automatically thrown in when operated.

The complete telephone has all connecting wires, binding posts and terminal screws fully concealed within its cabinet, so there is no liability of the parts becoming accidently disconnected and no exposed metal parts form any part of the circuits at any time, avoiding danger to the user from lightning or crossed lines with other electrical circuits, while using the instrument.

With all of the instruments in service for which there is a present demand, the municipality of Neepawa will have in operation over 180 subscribers, which shows one instrument for less than every nine inhabitants.

The Bell Telephone Company have purchased a site on west side of Mountain street, near St. Catherine street, Montreal, on which to build a modern up-town exchange.

Messrs. Benjamin Matthews, Aaron Sherk and John Baer, of Ridgeway, Ont., are establishing a telephone system connecting the villages of Port Colborne, Ridgeway and Fort Erie.

INDUCTION MOTORS.

Mr. H. A. Burson, M.Sc., chief electrical engineer of Allis-Chalmers-Bullock, Limited, Montreal, recently delivered to the students of electrical engineering at McGill University a series of addresses upon "Induction Motors," the manufacture of which the company make a specialty. The lectures were of an introductory character and discussed the theory of the rotating field in alternating current apparatus.

He first took up the winding of induction motors of different types and showed how the different distribution of stator winding affected the total magnetizing field, and described the relation of the maximum value of the induction to the average value. Some authors hold that the field distribution is as a sine wave, but Mr. Burson's experience was that it is not, but is a wave of such shape that the relation of the maximum to the average value is greater than that given by the sine wave.

Taking up the theory of the vector diagram as first propounded by Mr. B. Behrend, chief electrical engineer of the Allis-Chalmers Company, Milwaukee, he showed how the diagram for induction motors differed from that of alternating current transformers without leakage in that the locus of the end of the current vector lies on a circle, instead of on a straight line. This is due to the leakage which is necessarily present in induction motors.

He then took up the leakage factor—one of the most important features of induction motor design, about which, however, little is generally known—and showed that the leakage factor depended on the pole pitch, the width of core and the length of air gap. He also described the relation of the leakage factor to the magnetizing current and the diameter of the circle diagram, viz., that the diameter of the circle diagram is equal to the magnetizing current divided by the leakage factor.

Returning to the circle diagram he showed that the maximun power factor obtained from a machine depends directly on the value of the leakage factor and that hence the aim of the designer is to so construct a machine as to have as small a leakage factor as possible. The relation of the leakage factor to the over-load capacity was dealt with and it was shown that for the same magnetizing current an increase of leakage factor means a decrease in the over-load capacity of the motor.

Mr. Burson finally showed how to take into account the primary and secondary resistance losses and the iron losses, according to the method originated by Mr. Behrend, which he strongly recommended because of the simplicity of its application.

The town of Milton, Ont., has retained Mr. K. L. Aitken, of Toronto, as their consulting engineer in connection with the rebuilding of their electric light plant. A new power house will be built, and boilers, engine, generator, and switchboard installed. In all probability the system of distribution will be materially changed.

MUNICIPAL LIGHTING PLANTS.

The City Council of Calgary, N.W.T., have taken definite steps towards establishing a municipal lighting and power plant. The various companies supplying boilers, engines, etc., have sent in their tenders for the requirements of the town. The tenders were opened and the climax of a strenuous meeting of the Council was reached in a decision to proceed with the construction of the plant. However, the tenders were found to be so complicated that it was impossible to reach an intelligent decision in regard to them. This is an old story and due to the haste in which such matters are often decided.

Municipal ownership has been the subject of much discussion, and as we go to press, we note the rather unfortunate predicament in which the Town of Berlin, Ont., finds itself, in regard to the municipal gas lighting plant. We must congratulate the Calgary Council for the wisdom shown in calling a reliable consulting engineer to advise them in their important decision as to a municipal plant. If there is one thing more than another that throws discredit on municipal ownership, and makes such plants unsuccessful, it is an error made when the plant is originally installed. The plant is often installed under the supervision of the town engineer, who is usually a civil engineer and not familiar with steam or electric engineering. He is not supposed to be posted in this branch of engineering and cannot be blamed if his efforts in this direction are not successful.

MOONLIGHT SCHEDULE FOR MAY.

Date.	Light.	Date.	Extinguish.	No. of Hours.
May 1	7 30	May 2	4 10	8 40
2	7 30	3	4 10	8 40
3	7 30	4	4 10	8 40
4	7 30	5	4 10	8 40
5	7 30	6	4 10	8 40
6	7 30	7	4 10	8 40
7	7 30	8	4 10	8 40
8	7 30	9	4 10	8 40
9	7 30	10	4 00	8 30
10	10 45	11	4 00	5 15
11	11 30	12	4 00	4 30
13	0 10	13	4 00	3 50
14	0 45	14	4 00	3 15
15	1 20	15	4 00	2 40
16	2 00	16	4 00	2 00
17	No Light	17	No Ligh	
18	" "	18	" "	
19	" "	19	" "	
20	7 50	20	10 40	2 50
21	7 50	21	11 40	3 50
22	7 50	23	0 30	4 40
23	7 50	24	1 10	5 20
24	7 50	25	1 50	6 00
25	7 50	26	2 20	6 30
26	8 00	27	2 50	6 50
27	8 00	28	3 15	7 15
28	8 00	29	3 40	7 40
29	8 00	30	3 30	7 30
30	8 00	31	3 30	7 30
31	8 00	June 1	3 30	7 30
			Total............	172 45

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MONTREAL

Branch office of CANADIAN ELECTRICAL NEWS,
Imperial Building.

April 8th, 1905.

After reading the late Editorial on the enormous power lost by steam generation, one is quite prepared for the announcement on another page that the City of St. Thomas, Ont., have determined to try Oill ! !

The east end Bell Telephone exchange in this city is now complete and working by means of the Central Energy system. The Main exchange is now receiving attention and will be working Central Energy in a few months. This leaves only Westmount and Uptown; the former will no doubt be left with magneto ringers for some time to come ; but as Uptown is to have a new building, doubtless Central Energy will be installed there.

The small "Plumber and Electrician" gets in some fine work occasionally. One job noted lately showed brackets connected to gas pipes with hickeys (only), no joints soldered, fixture redone with aluminum bronze, the insulating joint being treated to coat of it, and bridging same—the fixture wiring itself being grounded ; two wires of a three way switch outlet coupled together and put in one side of an S.P. switch, ditto at other 3-way switch. This is a sample of competitive work in Montreal and the rabid desire for cheapness. Needless to say in above case the Montreal Light, Heat & Power Company refused to connect and the work had to be done over—not, however, by the plumber.

There is talk of opening and closing the locks, etc., at Lachine Canal by electricity. It is to be hoped the scheme will go through, as were any mariner asked the question, it is 10 to 1 he would state that the operation of Lachine canal is slower than any other from Lake Superior down. This should not be so at the final exit from inland to ocean navigation, and it is important, not only for Montreal, that electricity is to take the place of manual power.

The Trades and Labor Council were complaining to the Aldermen lately that the Montreal Street Railway did not build all their cars in Montreal as provided for in the franchise. True or not true, the fact remains that the very members of said organization are the principal complainants anent the scarcity of cars at 6 p. m. It looks very much as if the Council of Labor was trying to defeat the ends of their members.

Another brilliant scheme has been forwarded re. street railway fares in a letter to an evening newspaper, suggesting a zone system, or "penny per mile" scheme as worked in certain cities in Great Britain. If the correspondent uses the cars at the rush hours he would see that to do such would need a conductor of the strength of steel and speed of an express, not to mention a memory par excellence. Our conductors are only human beings and have their work cut out for them on cold nights giving transfers, which by the way are not given in the cities so glibly pointed out by the correspondent.

The discussion now going on in the English technical press re "Patrol busses vs. Electric Tramways" calls to mind the gasolene bus or automobile which last summer used to convey passengers from Victoria square via Victoria Bridge to St. Lamberts. It was as much as a lady's gloves or blouse (be they light in color) were worth to ride in it, and as the motor was always started up a minute or two before the journey, the effect of sitting in a cloud of gasoline smoke and heat can more readily be imagined than described. If the said South Shore Automobile Company want to make it popular, the sooner they re-arrange for electric propulsion the better. As it is practically a "level" trip, there should be no difficulty, and "charging" current could be arranged for at both ends if necessary from the A. C. mains of the Montreal L. H. & P. Company, by means of suitable motor and generator. The present arrangement can only be classed as a "horror".

Dealers in electrical supplies in Canada are in a more fortunate position than their confreres in the United States. There are many lines not yet manufactured in Canada which per force must be imported. When U. S. "trusts" get their prices too high for convenience then we can turn (often with profit) to Great Britain. Some American representatives are beginning to find that between the other side of the water and home manufactures their old happy hunting grounds here are getting played out.

The Montreal Light, Heat & Power Company have closed a contract for five years for lighting the harbor of Montreal. The lamps to be used are Western Electric series alternating arcs. They have also closed a contract with the Laprairie Brick Company to supply 1,000 h. p. The Laprairie Company are to build the line themselves, under the supervision of the Montreal Light, Heat & Power Company. This line will be tapped to the Chambly transmission line and will extend seven miles.

The Montreal Light, Heat & Power Company are supplying the Ogilvie Mills Company between 800 and 1,000 h. p. temporarily while the water is out of the canal.

CANADIAN GENERAL ELECTRIC COMPANY.

The annual meeting of the Canadian General Electric Company was held last month, at which it was decided to increase the capital stock of the company by $900,000.

The company's profits for the past year were shown to amount to $582,519.60, as against $512,210 for 1904. After paying dividends amounting in the aggregate to $392,763.52, the sum of $113,612.37 was written off for depreciation, $75,000 transferred to reserve, and $1,143.71 added to the credit of profit and loss account, which now stands at $81,913.42. Considerable sums were expended in creating the locomotive department, which is now on a normal manufacturing basis.

It was reported that from January 1 to March 5 contracts to the amount of $1,007,000 had been closed by the electrical department, and $381,000 by the foundry department. These amounts, added to the total unfinished business carried forward from 1904, make a gross total of $4,118,000.

THE CANADIAN WESTINGHOUSE COMPANY.

The first annual meeting of the shareholders of the Canadian Westinghouse Company, Limited, was held at Hamilton on March 28. The report submitted showed that during the fourteen months of its existence, and with only a portion of its plant in operation, the company earned $160,596, or over 6 per cent. upon the paid-up capital stock. The present year began with orders on hand of approximately $560,000. The assets of the company are placed at $2,926,724.43.

The directors' report stated that the new manufacturing plant was practically completed, and in a short time the manufacture of electrical apparatus would be commenced.

The following were elected directors:—George Westinghouse, H. H. Westinghouse, Hon. J. M. Gibson, Frank H. Taylor, Warren Y. Soper, L. A. Osborne, T. Ahearn, George C. Smith, C. F. Sise, Paul J. Myler.

At a subsequent meeting of the directors, Mr. George Westinghouse was elected president: Mr. H. H. Westinghouse, first vice-president ; Mr. Frank H. Taylor, second vice-president ; Mr. Paul J. Myler, third vice-president and treasurer ; and Mr. John H. Kerr, secretary.

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PERSONAL.

Mr. A. W. Brown has been appointed chief engineer at the electric light plant, Brockville, Ont.

Mr. E. H. Keating, formerly manager for the Toronto Railway Company, has been appointed manager and engineer of electric railway, power and light franchises owned by the Mackenzie & Mann syndicate at Monterey, Mexico.

Prof. L. A. Herdt, Professor of Electrical Engineering at McGill University, Montreal, has received from the Government of France the honorary title of Officier d'Academie, a distinction granted for services rendered in the field of art, science, and literature.

Mr. F. A. Huntress, who was for several years manager of the Halifax Electric Tramway Company and more recently has been general manager of the Worcester Consolidated Street Railway Company in Massachusetts, has just been appointed manager of the Rio Janeiro Light & Power Company, in which American and Canadian capitalists are largely interested. The many friends of Mr. Huntress will be pleased to learn of his appointment, which we understand carries with it a very substantial remuneration.

Following the appointment of Mr. R. J. Fleming as general manager of the Toronto Street Railway, comes the announce- of several changes among the superintendents of departments. Mr. Ewan Mackenzie, brother of President William Mackenzie, who has been assistant superintendent for several years, has tendered his resignation and will for the immediate future be engaged in the construction of the Metropolitan extension from Newmarket to Jackson's Point. Mr. Alex. Smith, who has been 21 years in the street railway service, and latterly as electrical mechanical superintendent, has resigned and is superseded by Mr. J. Donnelly, of Cincinnati. Mr. W. H. Moore, who has been assistant to President Mackenzie, will take no further par in the management, having been appointed secretary of the James Bay Railway and virtually managing director of the York Radial Railways. Mr. Edwin Whittaker, inspector, will also leave the company, having received an important appointment from Mr. C. E. A. Carr, manager of the London street railway. Mr. James H. Wallace, another inspector, has obtained a more lucrative position under Mr. E. H. Keating, resident manager of the Mackenzie & Mann electric railway interests in Monterey, Mexico.

SPARKS.

The Packard Electric Company, St. Catharines, Ont., have established a factory for the manufacture of automobiles.

The City Council of Montreal have received tenders for a waterworks pump and are now considering whether to purchase a steam pump at a cost of $53,000 or an electric pump at a cost of $16,000. Both pumps are to be capable of pumping 12,000,000 gallons every twenty-four hours.

A dispatch from New York, dated March 21, states that the Westinghouse Electric & Manufacturing Company are preparing plans for the construction of a huge electrical power plant at Grand Falls N. B., by a syndicate of New York, New England and Canadian capitalists, comprising the Electro Manganese Company, Burton E. Kingman, New York, Fred Sayles, Providence, and others.

American and Canadian capitalists have organized the Rio de Janerio Tramway, Light & Power Company, with a capital of $25,000,000. The objects of the company are to develop a large water power near Rio de Janerio and to transmit electric current to that city for electric light and power purposes. The promoters include Sir William Van Horne, of Montreal; Willia Mackenzie, E. R. Wood and Z. A. Lash, of Toronto, and F. S. Pearson, consulting engineer, of New York.

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Edited and compiled by C. S. Vesey Brown, M. Inst. C. E., M. I. E. E.

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(a) **Names and addresses** of all the **Directors, Members of Municipal Committees and the principal Officers** connected with each works, together with their postal and telegraphic addresses.

(b) **Technical description** of each works, showing the **"system of supply,"** detailed list of the **machinery, storage cells, cables, meters, etc.,** with which the **works are equipped,** giving the **makers' names** in each case, also **the prices charged for Light, Power and Traction.**

(c) The **financial results for the last completed year of working,** showing **capital expended, revenue and costs of generation, etc.,** are **given in detail.**

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SPARKS.

Mr. Blair has been appointed by the Town Council of New Liskeard, Ont., to report as to the best available water power in the district for electric lighting purposes.

The proprietors of the Windsor Hotel, Montreal, purpose building a large addition which will include a power house in which machinery will be installed capable of developing 1,000 h.p.

The Sydney Mines Electric Company have submitted a proposition to the Town Council of Sydney Mines, N.S., to furnish electric light at eleven cents a kilowatt hour, as against fifteen cents at present charged by the Cape Breton Electric Company.

It is announced that the Montreal Street Railway Company intend extending their Lachine line to Ste. Anns and around the island to Cartierville and River des Prairies, thence across the island to Longue Pointe. A portion of the extension will be constructed this year.

The Levis Electric Railway, of Levis, Que., which has encountered a multiplicity of difficulties for some months past, is completely tied up. One of the creditors is reported to have seized the road, but the New York Security & Trust Company have filed an opposition in which they claim to be the sole owners of the property.

The following are the new directors and officers of the Hamilton, Grimsby & Beamsville Railway Company: J. W. Nesbitt, K.C., President; John Dickenson, ex-M.P.P., Vice-President; J. R. Moodie, Treasurer; Hon. J. M. Gibson, J. W. Sutherland, W. C. Hawkins and John G. Gauld. George E. Waller is manager and secretary.

Mr. R. S. Kelsch, chief engineer of the Kakabeka Power Company, states that the surveys have been completed and plans are under way. The work on the canal will be started early next month. It is intended to deliver power in Fort William and Port Arthur May 1st, 1906. The falls are 24 miles from Fort William on the Kaministikwia river.

A project is now being considered to construct an electric railway connecting Steveston and New Westminster, B. C. The proposition is for the city of New Westminster to guarantee the interest at 4 per cent. for forty years on bonds to the extent of $100,000, the funds thus secured to be used for the construction of the road. The British Columbia Electric Railway Company may undertake the work.

The seventeenth regular meeting of the Toronto Branch of the American Institute of Electrical Engineers was held at the School of Practical Science on Friday, March 24th, when Mr. W. H. Fiske, of the Toronto Street Railway Company, presented for discussion a paper entitled "Two Motor versus Four Motor Equipments," which was read by Mr. N. McCrawford at the 194th regular meeting of the A.I.E.E.

The Quebec Railway, Light & Power Company intend constructing a dam on the Montmorency river this spring, to be 90 feet high, 12 feet wide at the top and 65 feet wide at the bottom. The construction of this dam will not only have the effect of doubling the power of the company, but will also give them an enormous storage reservoir containing over 50 million cubic feet of water to draw from in period of drought.

The Stave Lake Power Company, Vancouver, B.C., have retained the services of R. S. Kelsch and Wm. Kennedy, jr., of Montreal, to develop their water power. The falls are located on the Stave River, 42 miles from Vancouver. The power will be transmitted for distribution in Vancouver, New Westminister and vicinity. The immediate installation will be for 10,000 horse power, with an ultimate capacity of 35,000 horse power.

Mr. James Stuart, president of the Stuart Machinery Company, Winnipeg, has purchased the northern half of Miller & Morse's old warehouse on Princess street, in that city, and intends fitting up a modern electrical supply house to meet the requirements of the west. He has purchased the bankrupt stock of the E. S. Harrison Electrical Company. The company will be incorporated under the name of the James Stuart Electric Company, Limited.

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"The Whitney Company is the first and only one to attain this result and patent claims broadly covering all feasible means have been allowed. Of course, the Whitney Company does not intend to use the monopoly of this superior apparatus, which it has and intends to maintain by prompt prosecution of infringers, to obtain unfair prices or to accord its customers other than the same prompt attention and courteous treatment for which it has been known for years past. It does, however, intend to use it to establish itself still more firmly as a strong factor in the direct current instrument field."

The West Kootnay Power & Light Company, of Rossland, B.C., have just concluded contracts with the British Columbia Copper Company and the Granby Consolidated Mining & Smelting Company to supply them with 4,500 h.p. of electric power. This has rendered necessary the enlargement of their power plant and steps have been taken to develop the Upper Bonnington Falls to the extent of 20,000 horse power. A duplicate pole line will be constructed from Bonnington to Greenwood, each line to have a capacity of 6,000 h.p., which will be transmitted at 60,000 volts. Owing to the fact that the lower falls only gave a minimum head of 34 feet, sufficient power could not be developed to meet the demands of the company's present and prospective customers. At the upper falls a head of 58 feet is available. It is estimated that the new development and equipment will cost about a million dollars.

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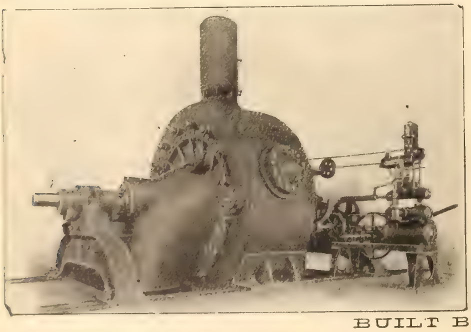

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SEND FOR TABLE CONTENTS

SPARKS.

The Richelieu Light & Power Company has been formed by Montreal capitalists, with a capital of $500,000. The company propose to supply Farnham, Iberville, St. Johns and surrounding districts with electric light and power. A plant on the Yamaska river has been acquired and will be enlarged.

The Windsor and Tecumseh Electric Railway Company have asked the Legislature for permission to extend their lines in the county of Essex and to legalize agreements with the Ontario Traction Company. An extension of time is desired for the completion of the Aylmer and North Shore electric railway.

Application will be made to the Ontario Legislature for a charter to incorporate a company to build an electric railway from Stratford to Grand Bend or Lake Huron, with branches to New Hamburg and Tavistock. Mr. James Steele, of Smith & Steele, barristers, Stratford, Ont., is solicitor for the company.

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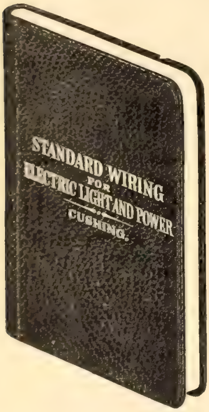

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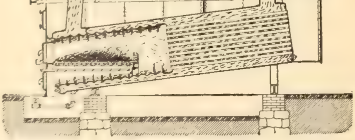

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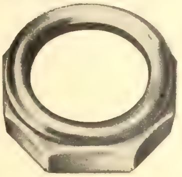

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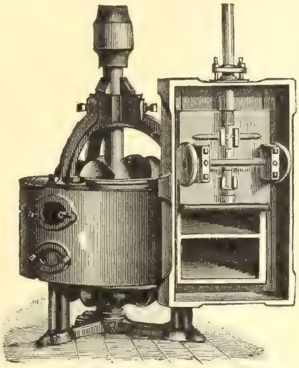
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SPARKS.

W. M. Reeser & Company have commenced business as dealers in electrical supplies at Regina, N.W.T.

The Village Council of Carberry, Man., are negotiating with Mr. Royce for the installation of an electric light plant.

The City Council of Ottawa, Ont., have decided to buy out the Consumers Electric Company, of that city, for $200,000.

The town of St. Mary's, Ont., is preparing a $15,000 by-law for improvements to the waterworks and electric light systems.

The city of Moncton, N.B., will be compelled at an early date to consider an expenditure of about $20,000 for improvements to the electric light plant.

A site has already been selected for the electric light plaut to be installed by the municipality of westmount, Que. A 600 horse power plant has been installed.

The Canadian General Electric Company, Toronto, have secured the contract for a waterworks pump and electrical apparatus for the corporation of Sudbury, Ont.

The construction of an electric railway at Edmonton, N.W.T., is taking definite shape, as the contract for the power house has been awarded to Mr. Charles May.

Mr. K. L. Aitken, consulting engineer, Toronto, has recently returned from Sarnia, where he made a complete inspection of the electrical equipment of the Imperial Oil Company.

The Toronto & York Radial Railway Company have asked the Ontario Legislature to extend the time for the completion of their lines and for permission to construct an extension to Bowmanville and Cobourg.

Messrs. Bristol, Bayly & Armour, barristers, Toronto, give notice of application to the Ontario Legislature for an act to incorporate a company to construct a railway from Toronto to Ottawa.

The City Council of Charlottetown, P. E. I., have appointed a committee to prepare a bill asking the Provincial Legislature for power to issue $75,000 of debentures for the installation of an electric light plant.

Mr. John Galt, C. E. & M.E., of Toronto, has prepared plans for waterworks, sewerage and electric light systems to be constructed by the municipality of Indian Head, N.W.T. It is proposed to submit a by-law to the ratepayers to raise $140,000 for the purpose.

Messrs. W. J. Aikens, W. F. Haskins and James Rolton, of Dunnville, J. S. Hamilton and W. G. Elliott, of Brantford, and N. B. Gash, of Toronto, are seeking incorporation for the purpose of constructing an electric railway from St. Catharines to Dunnville and Port Dover.

A Dominion charter has been granted to the Grand Falls Power Company, Limited,, of Grand Falls, N. B., with a capital stock of $200,000. It is proposed to undertake an extensive water power development at Grand Falls and to establish a pulp mill and other works. The incorporators inclnde Sir William C. Van Horne, of Montreal; Hon. Redfield Proctor, of Proctor, Vermont, and H. H. McLean, barrister, of St. John, N.B.

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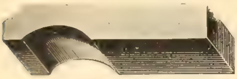

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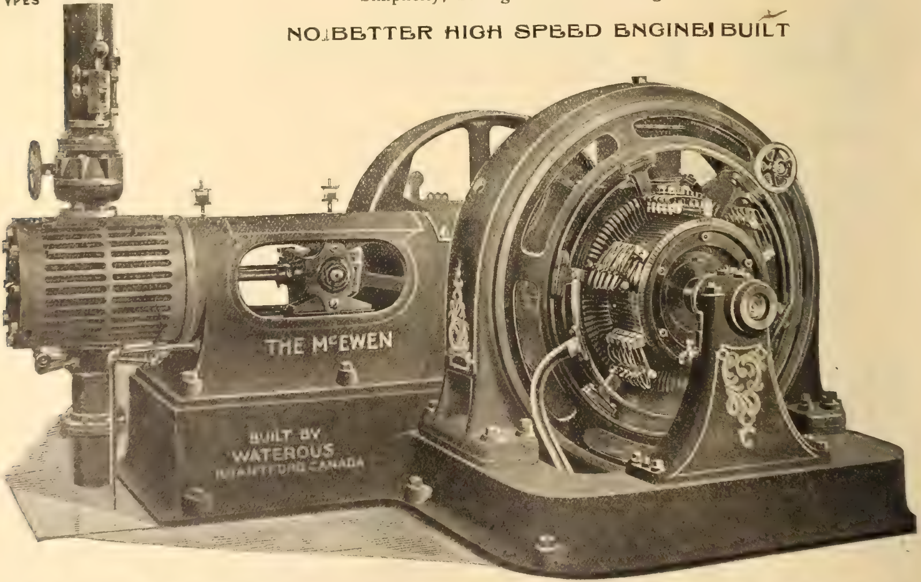

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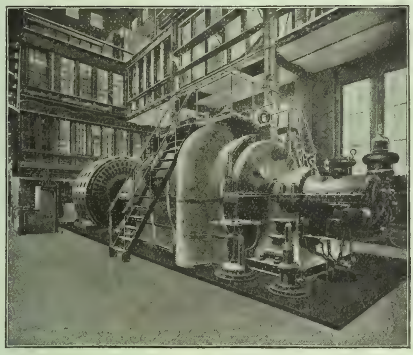

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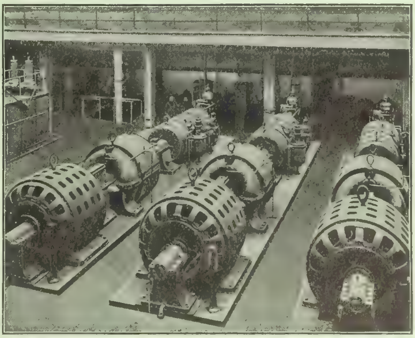

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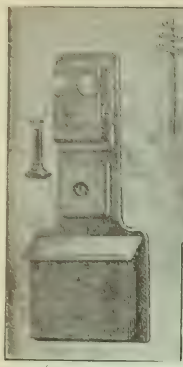

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No. 5.

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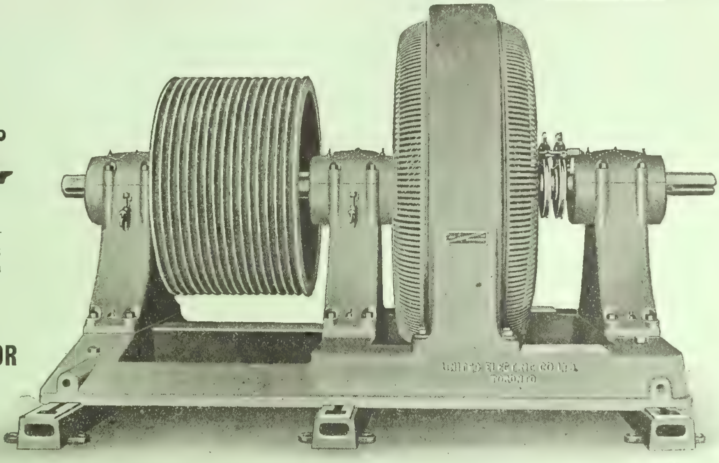

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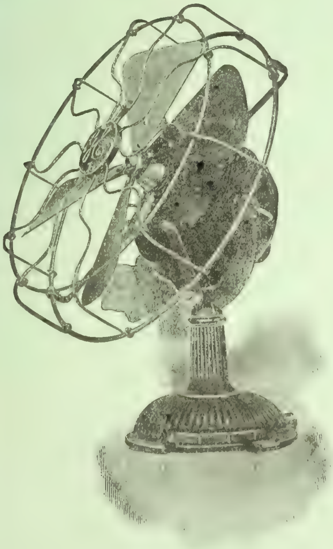

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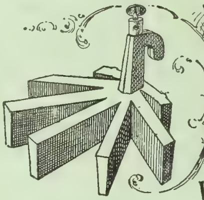

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THE CANADA METAL CO.
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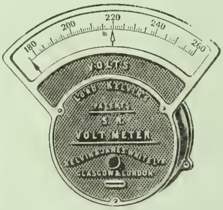

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MANUFACTURERS OF
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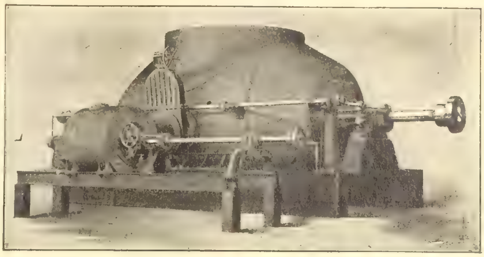
4,000 H. P., 80 ft. head, arranged to drive generator and a single turbine to drive exciter. Seven settings built for the Hudson River Water Power Company for their Spier Falls plant and 14 pairs 51 inch for their plant at Mechanicsville, N. Y.



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Write for catalogue if contemplating purchase of Turbines.

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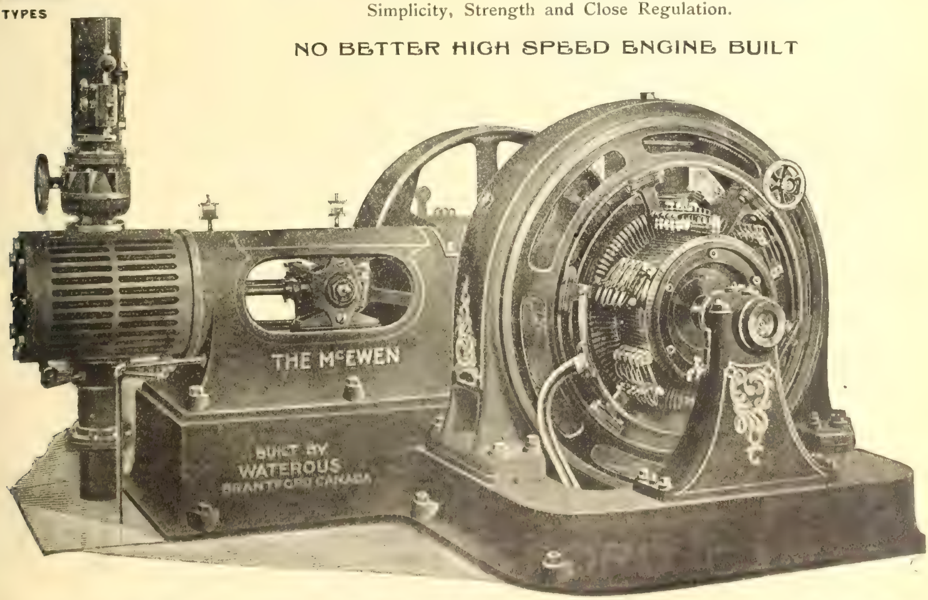


WATEROUS. BRANTFORD, CANADA

TELEGRAPH and TELEPHONE

C. P. R. TELEGRAPH IMPROVEMENTS.

In an interview in Winnipeg recently, Mr. James Kent, manager C. P. R. Telegraphs, stated that extensive additions were contemplated this year. Among the projects of extension are the stringing of new wire from Winnipeg to the Pacific coast. Mr. Kent said that the company was going to pursue vigorously the policy of increasing facilities wherever they could be advantageously increased. During the coming summer two heavy copper wires will be strung south over the new Soo line to Minneapolis, which will give Winnipeg the shortest and most direct connection with Minneapolis and Chicago. On the main line west of Winnipeg an additional heavy wire will be strung to the coast, and more wires will also be put west of Brandon. Additional wires will be strung between Calgary and east and west Kootenay points along the Crows Nest.

At Winnipeg the company will have as complete telegraph terminals as are to be found on the continent. The wires entering and leaving the city have been put underground. The wiring and equipment in the new station are of the most modern type and will add considerably to the telegraph facilities of the city.

The Haileybury & Cobalt Telephone Company, Limited, of Haileybury, Ont., has been incorporated, with a capital of $5,000. The directors are Messrs. H. McQuarrie, T. H. Gorman and P. A. Cobold.

The Campobello Island Telephone Company, Limited, has been incorporated by the New Brunswick Government, with a capital stock of $2,000 and head office at Wilson's Beach, N. B. William E. Ludlow is one of the promoters.

The Temiskaming Telephone Company, Limited, has been incorporated to construct and operate telephone lines in the district of Nipissing, Ont. The head office of the company is to be at New Liskeard and the capital stock is $25,000. Messrs. Thos. McCamus and J. J. Sparling are provisional directors.

The Nova Scotia Telephone Company intend making extensive improvements this spring. A metallic wire will be run from Amherst to Springhill and Parrsboro, and another to West River, Pictou County. A direct metallic line will also connect with the New Brunswick Telephone Company's line at the boundary.

The Board of Commissioners of the Temiskaming and Northern Ontario Railway decided, at a recent meeting in Toronto, to inaugurate a government-owned telephone system for the entire length of the railway. For the present the telephone line will be built from North Bay to New Liskeard, a distance of 113 miles, but as the railway is extended northward the telephone system will also be extended.

SHORT CIRCUITS.

The British Columbia Telephone Company are rebuilding their line from Cascade to Phœnix.

The Bell Telephone Company are placing their wires underground in the city of London, Ont.

T. J. Tilley, Peterborough, has been appointed manager of the Bell Telephone Co.'s business at Lindsay, Ont.

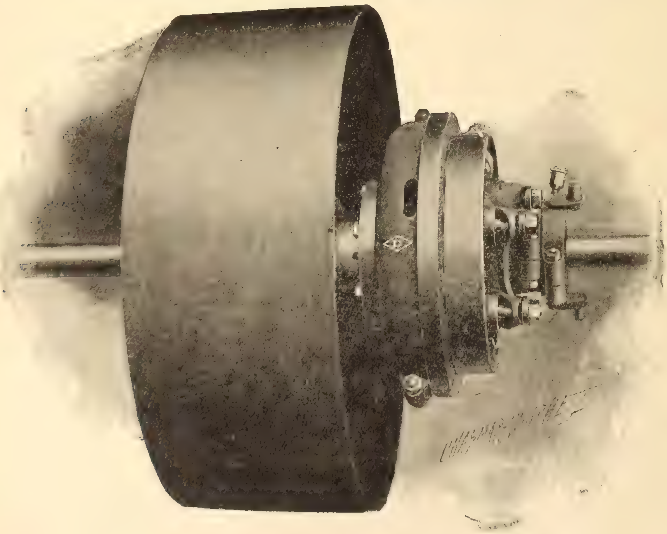
It is understood that the Bell Telephone Company intend to place three miles of their lines in Montreal underground the coming summer.

Buyers of electrical supplies will find much of interest in the various catalogues to be had from J. A. Dawson & Company, 743 Craig street, Montreal.

A recent booklet from the Weston Electrical Instrument Company, Newark, N. J., describes the many electrical measuring instruments manufactured by them.

The John McDougall Caledonian Iron Works Company, Montreal, are Canadian agents for Wickes Bros., of Saginaw, Mich., and are distributing a neat booklet referring to the Wickes vertical safety steam boiler.

The DODGE SPLIT FRICTION CLUTCH PULLEY



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NEW ELECTRICAL DEVICE.

A new electrical fire discoverer, alarm and extinguisher, the invention of Mr. Peter Steins, is now undergoing satisfactory tests in Montreal. This instrument is composed of two parallel disc in same position made of band corrugated special heavy metal. They are enclosed in a hermetically closed cylinder, or case, about half an inch space between them ; the former one is practically exposed to smoke, the latter is almost closed from smoke, consequently the working of the instrument is that it is hung on the ceiling ; the plates are treated chemically so that by smoke only they form an expansion. As the smoke reaches the former parallel plate more quickly than the second one, it expands, which gives a contact that naturally sets off the new electrical trumpet and turns on water, indicating in which department the accident of fire has occurred and lighting the electric lights in the meantime. In about twenty or thirty seconds of smoke, practically the beginning of the first of the fire, the extinguisher contracts and turns on the water. There being no more development of smoke, the plate contracts again in previous position and breaks the current and naturally turns the water oft and ceases giving the alarm. This new electrical fire alarm extinguisher is being approved by the Fire Committee of of Montreal and also is now installed in a number of the largest factories in Canada such as the Canada Sugar Refining Company, also the fire stations in Montreal.

Mr. Steins, who is a civil engineer, is of English descent, and has studied for years in Germany and Holland. His patent has been introduced largely, he says, in Europe, but the electric horn, a wonderful thing in itself, he invented since coming to Montreal, a year ago.

The town of Sudbury, Ont., have contracted with the Sudbury Power Company for the necessary power to operate their lighting and waterworks systems. It is expected the power will be ready for delivery about the middle of June, and the town are therefore making the necessary alterations and improvements to the plant. They are installing a new marble switchboard with instruments and apparatus necessary for 2,200 volt operation, also an 800 gallon per minute turbine pump direct connected to an 80 h.p. induction motor. The contract for the new equipment has been given to the Canadian General Electric Company.

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We use the latest and most approved methods in our works. We buy and sell second-hand apparatus.
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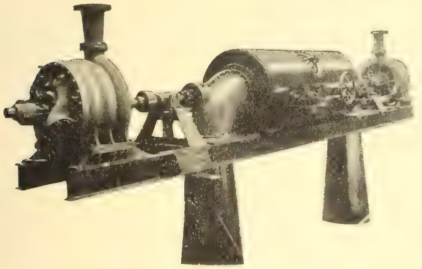
GIVE US A TRIAL.

"WORTHINGTON" TURBINE PUMPS
(MADE IN CANADA)



Two Worthington 3-Stage Turbines & McCormick Water Wheels, built for Port Arthur, Ont., Water Works
Combined capacity, 1440 gallons per minute, against 350 feet head.

DESIGNED FOR HEADS UP TO 2000 FEET.
BELT, STEAM OR ELECTRIC DRIVE
RELIABLE, DURABLE, EFFICIENT & EXCEEDINGLY SIMPLE

Amongst those we have supplied with Turbine Pumps, are—
Town of Smith's Falls, Ont., 1-5" 2 stage. Electric driven.
Town of Lachine, Que., 2-8" single. Electric driven.
Town of Lethbridge, N. W. T., 2-6" 3-stage ; 2-6" single. Electric driven.
Town of Port Arthur, Ont., 2-5" 3 stage. Direct connected water wheel.
Town of Marieville, Que., 1-4" 2 stage. Belt driven.
City of Winnipeg, Man., 1-12" 2 stage. Electric driven.
International Portland Cement Co., Hull, P. Q., 2-5" single. Electric driven.
Canada Sugar Refining Co., Montreal, P.Q., 1-8",2 stage, etc., etc. Electric driven.

The John McDougall Caledonian Iron Works Co., Limited, Montreal, Que.
BUILDERS FOR CANADA.

SPARKS.

The Canadian General Electric Company, of Toronto, have increased their capital stock to $5,000,000.

The bondholders of the street railway at Kingston, Ont., have decided to dispose of the road at auction.

The T. Eaton Company will install four 250 horse power boilers and two engines in their new departmental store in Winnipeg.

The Fairville Electric Light Company, Limited, of Fairville, N.B., has been incorporated, with a capital of $2,500, to furnish electric light in that village.

The factory of the American Furniture Company at Oxford, N.S., in which was located the electric plant for lighting the village, was destroyed by fire early in April.

Mr. Claude McPhee, of Arnprior, Ont., has perfected an electrical device for the prevention of train collisions on railways, and is said to be forming a company to exploit the invention.

The contract which the Goldie & McCulloch Company, of Galt, Ont., have secured from the Olds Flour & Elevator Company, Olds, N.W.T., includes a 100 h.p. single cylinder Wheelock engine, two 65 h.p. boilers and a 700 light generator.

The ratepayers of Seaforth, Ont., last month defeated a by-law authorizing the Council to purchase the electric light plant, which shows that the ratepayers of that town have not yet become afflicted with the "frenzy" for municipal ownership.

The Canadian Manufacturing Company, Limited, was organized in Montreal last month, with a capital stock of $40,000. Their charter gives them power to carry on the business of manufacturing and dealing in dynamos, motors, steam turbines and general machinery. The incorporators include Messrs. L. Rubenstein and H. J. Elliott, of Montreal, and A. D. Gall, of Westmount.

The city of Moncton, N.B., are about to increase the electric plant, and have given the contract for an engine to the Robb Engineering Company, of Amherst, N.S., at $5,600. The Goldie & McCulloch Company, Laurie Engine Company, Jenckes Machine Company, and E. Leonard & Sons were the other tenderers. The Canadian General Electric Company, Canadian Westinghouse Company, Allis-Chalmers-Bullock and R. E. T. Pringle tendered on generator and accessories, but at time of writing the contract had not been awarded.

The Canadian Westinghouse Company, Limited, recently sold to the Edmonton (Alberta) Street Railway Company a 200 k.w. railway generator and a number of double equipments of railway motors. The city of Edmonton is the most northerly point on the American continent to operate an electric street railway. Another recent sale made by the Canadian Westinghouse Company, Limited, was that of a 500 k.w. enclosed type turbo-generator unit to the Canadian Pacific Railway Company. This unit is to be installed at Fort William, on the C.P.R., and to be used for supplying power to the various grain elevators at that point. The unit is to operate three phase, 600 volt, 7,200 alternations, 3,600 r.p.m.

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FOR SALE
$5.00 PER SET
SLIGHTLY USED BUT IN GOOD ORDER
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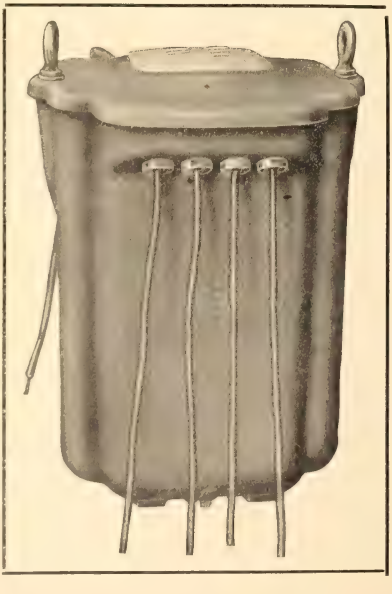
178 Mountain Street, MONTREAL, QUE.
or to any Local Manager of THE BELL TELEPHONE COMPANY OF CANADA.



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The
PACKARD ELECTRIC COMPANY
Limited
ST. CATHARINES
MONTREAL - - WINNIPEG

SPARKS.

A company has offered to install an electric light plant at Yorkton, N.W.T.

The Campbell Electric Company, Edmonton, N.W.T., has been succeeded by the Northwest Electric Company.

It is understood that the Canadian General Electric Company have found it necessary to build a large addition to their works at Peterboro, Ont.

The Town Council of Windsor, Ont., have decided to submit a by-law to the ratepayers to raise $30,000 for remodelling and extending the electric light plant. The vote will be taken on the 12th inst.

The Interior Power Company, Limited, capital $25,000, and the West Coast Power & Light Company, Limited, capital $50,000, have been incorporated by the British Columbia Government.

The Nanaimo Electric Light Company, Nanaimo, B.C., have just completed a new brick power house, 38 x 68 feet, built on the banks of the Millstone River, this step being rendered necessary by the demand for increased power.

The Ingersoll Waterworks Company, Ingersoll, Ont., have made arrangements to substitute electric for steam power at the pumping house, the current to be obtained from the Ingersoll Electric Light & Power Company, who have recently installed a 100 h.p. alternating current generator.

Messrs. Penniman & McGuire, of Providence, Rhode Island, have commenced work on the large dam of the Koochiching Power Company at Fort Frances, Ont. The first work to be done, the large coffer dams, will require 4,000,000 feet of timber, after which the main dam will be built. It is estimated that the works will consume 100,000 barrels of cement, and that the total expenditure will exceed $3,000,000.

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"COHESIVE" Inner Globes
and
"FABIUS HENRION NANCY" Carbons
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Mr. Thos. A. Edison thinks so. See what he writes:

From the Laboratory of Thomas A. Edison,
ORANGE, N. Y., Feb. 21st, 1905.
THEO. FEILDEN, Esq.
Electrical Magazine, 4 Southampton Row,
London, W. C., England.

My Dear Feilden; Yours of the 8th received. Replying to same wish to say that when the Electrical people do anything, it is up-to-date and excellent, that is the case with your Souvenir Edition, its hard to beat. Yours truly,
(Signed) THOS. A. EDISON.

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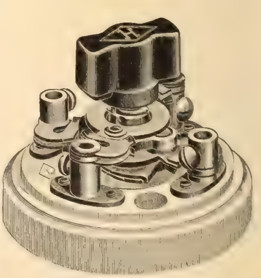

MONTREAL

Branch office of CANADIAN ELECTRICAL NEWS,
38 Alliance Building.

April 10th, 1905.

The municipal plant for the suburb of Westmount is under way. A site has been chosen, but to secure proper entrance, considerable more land than estimated has been called for. The price asked is also much greater than figured, and the matter will probably go to arbitration. This kind of a start is not calculated to increase the residents' faith in the plant and is a poor "foundation" to hand over to Messrs. Ross & Holgate, who we understand are the electrical engineers, and who will be employed on a percentage basis to install and equip the plant. The sooner the affair is arranged so that matters henceforth will be run on a business basis—the better.

There has been quite an influx of young practical electricians from England lately, some bearing excellent testimonials, and looking for positions in Montreal.

There is considerable activity in electrical circles in this city, and a general anticipation that the forthcoming convention of the C.E.A. will be a great success. The local committee is one of the best that has ever been named. The arrangements promise to give satisfaction to all, and the splendid meeting room of the Canadian Society of Civil Engineers at 877 Dorchester street, which has been secured for the purpose, will permit of the business of the convention being carried on without the slightest interruption from any cause. The local committee are to be congratulated upon securing these quarters. The Montreal Street Railway Company have promised free transportation.

The electrical industry in this city is growing very rapidly and apparently the advantages of the electric drive are becoming fully appreciated by the users of power. The Ogilvie Milling Company are about to install an induction motor plant of the highest order. We understand that Mr. F. McC. Robertson, of the Montreal Light, Heat & Power Company, is the consulting engineer for the work and that the contract for electrical apparatus has been secured by the Allis-Chalmers-Bullock, Limited.

The consulting engineers are quite busy. Messrs. Ross & Holgate have in hand extensive additions and improvements to the plant of the West Kootenay Power and Light Company, of Rossland, B.C. This company have in view a further development of power to meet the demands from the mines and for lighting and other purposes. The remodelling of the plant of the Brantford Electric and Operating Company has been placed in the hands of Mr. R. S. Kelsch. They purpose changing their system to 60 cycles and installing new apparatus.

The report is current, and generally accepted, that Messrs. J. G. White & Company, the noted engineering firm of New York, have applied for letters of incorporation in Canada with the object of entering the Canadian field. As Mr. P. G. Gossler, their vice-president and engineer, is widely known in this country and is one of the first engineers of to-day, the success of such a venture would seem to be assured, and they will no doubt soon become an important factor in electrical engineering in Canada. It is understood that the name to be adopted is the Canada White Company.

Among the busy electrical contractors is Mr. Philip Lahee, of the Temple Building. He is reconstructing the wiring in the Street Railway building and the Victoria Hospital, and is installing new wiring in the Alexandria Hospital, Royal Victoria Hospital and Dow's brewery. He has also several important contracts in Winnipeg, including the C.P.R. station and hotel, Free Press building, Bell Telephone building and a large residence for Mr. Galt. All the above work will be done in the conduit system.

The McLeod Electric Light & Power Company, McLeod, N.W.T., have installed an electric plant at Coleman.

Mr. W. T. Watson has opened up a light engineering workshop on Granville street, Vancouver, and is making a specialty of developing inventions and model making in both mechanical and electrical branches.

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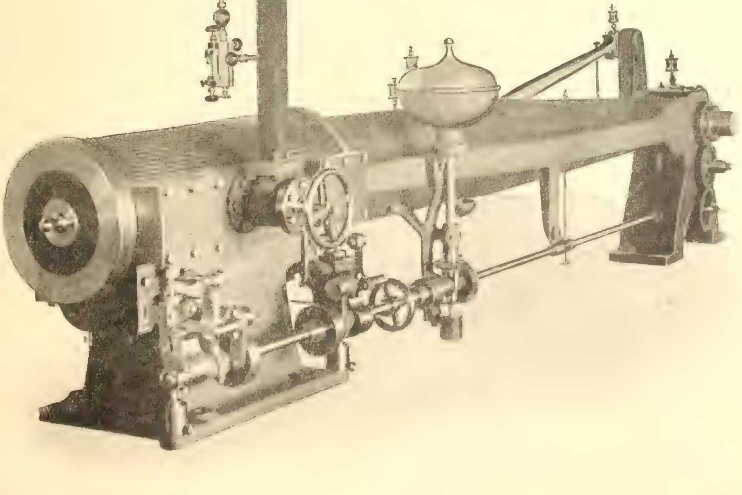

THE BROWN AUTOMATIC ENGINE.

SPARKS.

Mr. J. H. Boyes is negotiating for the installation of an electric light plant at Carberry, Man.

The electric light plant at Norwood, Ont., owned by W. C. Harrison, was totally destroyed by fire on April 21st.

The ratepayers of Dauphin, Man., voted almost unanimously in favor of a by law to raise $25,000 to install a municipal electric light plant.

The Dominion Coal Company have installed in their power house at Louisburg, N.S., a 35 k.w. C.G.E. generator direct connected to engine.

The village of Bobeaygeon, Ont., may be lighted by electricity in the near future, as the Council have the question under consideration.

The village of Lethbridge, N.W.T., have increased their electric light plant, the apparatus being furnished by the Allis-Chalmers-Bullock, Limited.

The Windsor & Tecumseh Electric Railway Company have taken tenders for the construction of their road. Mr. W. F. Brown is manager of the company.

A by-law to raise $160,000 for the completion of the waterworks, sewerage and electric light systems at Regina, N.W.T., was carried by the ratepayers a fortnight ago.

A syndicate is being formed to develop electric power at Lyndhurst, Leeds County, Ont., where there is an excellent water power. It is proposed to supply villages within a radius of 25 miles.

A power house will be built in connection with the C.P.R. hotel now under construction at Victoria, B.C. An ice-making plant and a high pressure pumping plant will be features of the building.

Mr. J. M. Campbell, of Kingston, Ont., is engineer for the new electric railway now under construction at Edmonton, N.W.T. It is expected that the road will be in operation by September next.

The property owners of Ottawa will vote on May 18th on the proposition for the purchase by the city of the Consumers' Electric Company's plant and line. The amount to be provided is $500,000.

New York capitalists, including Messrs. B. E. Kinman and F. C. Saylor, were at Grand Falls, N.B., towards the end of April inspecting the site of the proposed power plant. They offer to give the town 200 horse power, which will be sufficient to operate a system of waterworks and electric light, in return for the deed of some common lands suitable for an industry of some kind. It is the intention of the syndicate to commence work immediately.

Mr. James Hutcheson, president of the West India Electric Company, Limited, and Mr. Henry Holgate, one of the directors, of Montreal, have recently been on a visit of inspection of the company's plant at Kingston, Jamaica. It is reported that negotiations have been under way for the purchase of the Jamaica Electric Light Company by the West India Electric Company, and that the visit of these gentlemen is likely to result in a deal being closed.

Messrs. W. Moore & Sons have submitted an amended proposition to furnish electric light and power at Meaford, Ont. They offer to furnish a midnight lighting service under a ten-year contract at $45 per lamp per year; five-year contract, $50; less than five years, $55. For an all-night service they ask $60, $65 and $70 respectively, the moonlight schedule to apply. They offer to operate the pumping plant for 50 per cent. of the gross receipts by the town for water services.

An electric light plant has been installed at Bankhead for the purpose of lighting that place and Banff, N.W.T. The power house is a brick building about 100 x 60 feet, in which have been installed C.G.E. generators and Corliss compound high speed engines. The plant will be capable of supplying 6,000 incandescent lights and 20 series arc lamps, ten of the latter to be located at Banff. The current for Banff will be supplied at 6,500 volts to a sub-station, where it will be transformed to the voltage required for lighting the town. The C.P.R. hotel will also be lighted, and the independent plant there shut down.

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SPARKS.

Messrs. J. Y. Griffin & Company, of Winnipeg, Man., have asked for a franchise to supply electric light and power to the village of Louise Bridge.

The Waterworks Committee of the Town Council of Renfrew, Ont., have reported that a saving of at least $600 per year could be effected by installing electric pumps.

The West Coast Power & Light Company, Limited, has been incorporated by the British Columbia Government, with a capital of $50,000. The Surf Inlet Power Company, Limited, has also been incorporated in the same province, capital $50,000. Particulars regarding the proposed location of these companies can be obtained, upon payment of a small fee, from Mr. S. Y. Wootten, Registrar of Joint Stock Companies, Victoria.

The annual meeting of the Brantford Electric & Operating Company, Brantford, Ont., was held on April 14th. It is understood that the question of installing a new steam plant was discussed, but nothing definite is likely to be done until it is known whether the City Council will grant the extension of their franchise which has been asked for. It is reported that Messrs. H. R. Yates, W. Yates and Dr. H. B. Yates have disposed of their interests in the company.

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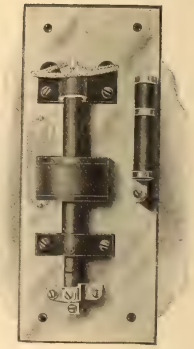

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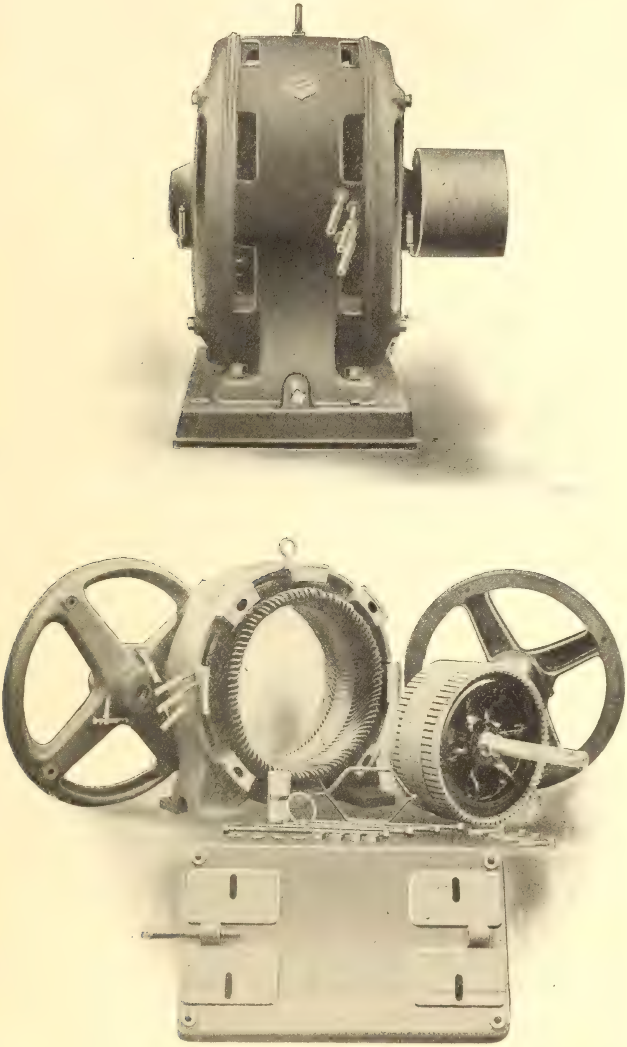

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CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XV. MAY, 1905 No. 5.

ELECTRIC POWER DEVELOPMENT IN SOUTH AMERICA.

That Canadian capital can be employed to advantage to develop foreign enterprises is demonstrated by the results accomplished by the Sao Paulo Tramway, Light & Power Company, which, as many of our readers know, was organized under an Ontario charter in 1899 to undertake an electric power development at Sao Paulo, Brazil. Sao Paulo is the most progressive city in Brazil, and has a population of about 300,000. The capital stock of the company was placed at $6,000,000, which has since been increased to $7,500,000. The present officers are: President, William Mackenzie, Toronto; first vice-president, Frederic Nichols, Toronto; second vice-president, Alexander Mackenzie, Sao Paulo; manager, James Mitchell, Sao Paulo; secretary treasurer, J. M. Smith, Toronto; assistant treasurer, D. Mulqueen, Sao Paulo.

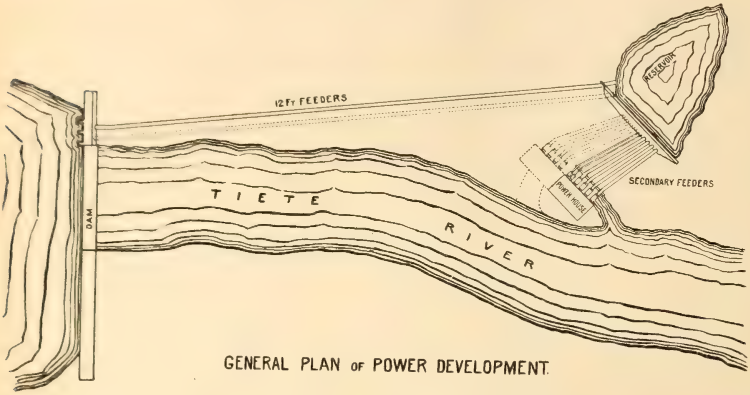
The company obtained a franchise for forty years from July 17, 1901, for the operation of electric street railways in the city of Sao Paulo and acquired existing roads, which have been converted from steam or animal power to electric traction, the total length of the system now in operation being about 70 miles. They also secured extensive electric light and power franchises from the City and authority from the State to erect poles, wires, etc., for the transmission of electric energy. Upon the advice of Mr. Hugh L. Cooper, of New York, it was decided to purchase the water power of the Teite river at Parnahyba, about 20 miles from Sao Paulo. At this place there is a fairly uniform drop in the river of 37 feet in a distance of about 2,500 feet. The basin above the rapids thus produced has an area of approximately 2,700 square miles. Allowing for a shrinkage of 40 per cent. in the estimated lowest water, the power available is estimated at 20,000 h.p. per 12 hours during the season of lowest water.

SAO PAULO TRAMWAY, LIGHT & POWER COMPANY—GENERAL VIEW OF TIETÉ RIVER.

DAMS AND PIPE LINES.

Plans for the hydraulic work were prepared by Mr. Cooper and subsequently carried out under his supervision. The work was commenced in January, 1900. At the head of the rapids a dam was constructed across the river, raising the original level of the water 39 feet. It is 860 feet long, 36 feet in width at the base, and varies in height from 39 to 73 feet, according to the elevation of the bed rock. The dam is constructed throughout of granite. The up and down stream faces are in ashlar in courses from 24 to 36 inches deep, 85 per cent. being of the latter depth. The interior of the dam is laid up in rough granite backing, the stones being as large as could be handled with 10 ton derricks; the average cubic contents of each piece laid, taking the face and backing together, was 51 feet. The dam contains 23,000 cubic yards of masonry and the work of construction occupied thirteen months. The storage reservoir formed by the dam is about eight miles long, with an average width of 1,000 feet.

Four hundred and sixty feet of the length of the dam consists of a runway for the handling of surplus water at flood and other times, being designed to take care of a flood aggregating 2,200,000 cubic feet per minute.



Sao Paulo Tramway, Light & Power Company.

The original pipe line which conducts the water from a pond into a secondary reservoir is 12 feet in diameter and 2,300 feet in length, built of ⅜ steel. This pipe was assembled and riveted in place, ¾ inch rivets being used throughout and all horizontal seams double riveted. It is supported by steel saddles resting on masonry pedestals 12 feet apart and is divided by expansion joints into four sections of 575 feet each. A duplicate pipe line was constructed and put into service in the early part of 1903.

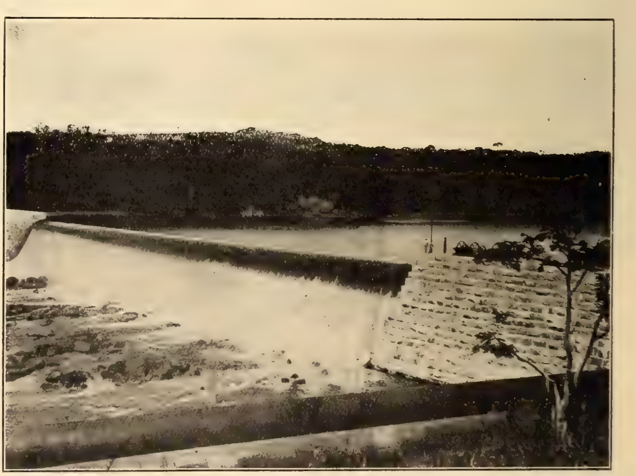
A second compensating open reservoir has been formed by a masonry dam, constructed of the same materials and in the same manner as the principal dam, containing 15,000 cubic yards of masonry. Three sides of the reservoir are formed by a high hill, and it has an approximate capacity of 560,000 cubic feet. It was decided to construct this secondary reservoir at the lower end of the main pipe to afford a cushion for the regulation of the flow of the water through the pipe, and thus to destroy the impact which results from a sudden stoppage of flow within a closed tube. It has been demonstrated that the difference in the pressure during the period of the greatest changes in velocity is less than six per cent., the desired result in regard to impact being thus fully accomplished. The use of this secondary reservoir is believed to be unique.

From this reservoir the water is conducted to the turbines through steel feeder pipes, each of eight feet diameter, and each supplying the necessary water for a horizontal turbine of 2,000 horse power. These feeders are 210 feet long, and are provided with a bell-mouth ten feet in diameter, for the reduction of the loss of head due to entry. The initial installation was for four feeders for four turbines, and two feeders, 36 inches in diameter, for the exciters, but provision was made for the duplication of the plant.

POWER HOUSE.

The power house is 52x104 feet, built of steel and brick, with a tile roof and tile floors laid in cement. The foundations of the power house and of all machinery within it are constructed of granite, and rest on the solid granite bed rock. The building is thoroughly fireproof.

The turbines, of which there are four of 2,000 horse power each, are of the horizontal twin type, each runner being 48 inches in diameter and making 200 revolutions per minute. The runners discharge into vertical draught tubes 9 feet in diameter, which in turn discharge the water into the tail-race under the turbines, whence it is conducted to the river, 900 feet away. Lombard governors are used. The regulation obtained by the use of the secondary reservoir is one and one-half per cent. from normal either way, on a street railway circuit where the amperage requirements vary from 500 to 2,000 amperes in seven seconds. The horizontal shaft of each turbine is directly connected to the shaft of the generator. The current is generated at 2,300 volts, and is stepped up to 24,000 volts, at which pressure it is transmitted to Sao Paulo.



Sao Paulo Tramway, Light & Power Company—Main Dam (Photo Taken at Season of Low Water.

ELECTRICAL PLANT.

The generating apparatus consists of four 1,000 k.w., 2,300 volt, 60 cycle, 3 phase alternators of the revolving field type, direct connected to the turbines already described. These generators are capable of developing 1,400 k.w. without injurious heating. There are two exciters, 100 k.w. 125 volt, direct connected to turbines and operating at 600 r.p.m., each exciter being of sufficient capacity to supply the exciting current for the four generators. The exciter switchboard consists of two panels for the exciter and one feeder panel containing nine circuits, viz., three for the blowers which supply air for cooling the transformers and six for the station lights and the exciting circuits of the generators.

Sao Paulo Tramway, Light & Power Company Main Pipe Emerging from the Dam.

The low tension switchboard is equipped throughout with two sets of bus-bars, so that the generators may be operated on two separate services, independently of each other. There are two station panels on which is recorded the total station output, and four three phase transformer panels. Each of the transformer panels has oil switches for controlling the low tension side of a bank of three transformers, which are connected in delta to the bus-bars.

Twelve 333 k.w. transformers wound for 2,300 volts receive the current from the generators and step it up to 24,000 volts for transmission. They are of the air-blast type, cooled by three seventy-inch Buffalo blowers, each driven by a three horse power direct current motor. Two of the blower sets will supply sufficient air to cool the transformers when fully loaded.

The high tension switchboard is made up of four panels for the high voltage side of the transformers, which are connected in delta, and two panels for the transmission lines. This switchboard has two sets of bus-bars so arranged that either transmission line can be operated from any set of transformers and generators. Two ground detectors are also on this switchboard.

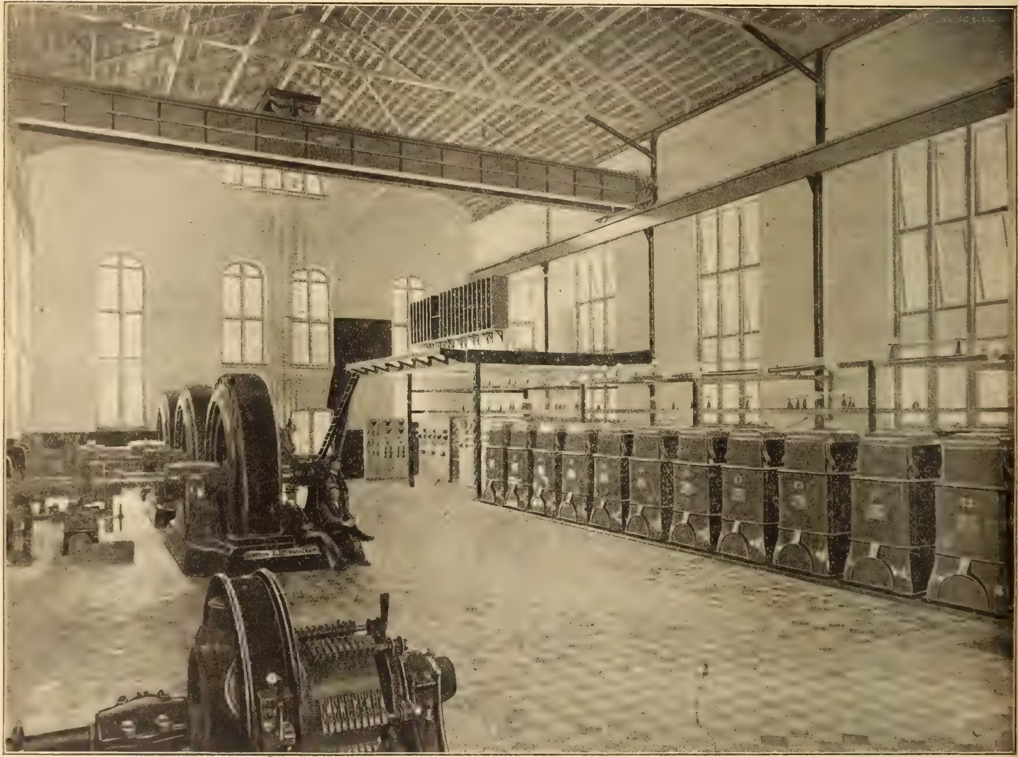
Six 24,000 volt lightning arresters are located in the terminal room through which the transmission lines pass. Each arrester is connected to a transmission conductor through a switch. All high voltage switches except on the high tension switchboard are of the oil type. The panels are made of blue Vermont marble. Each 2,200 volt switchboard panel carries the necessary indicating watt-meters, volt-meters and ampere-meters for indicating the performance of the apparatus. All the electric apparatus for the generating plant was supplied by the General Electric Company.

For street railway service the current is transformed from 2,200 volts alternating to 575 volts direct; for lighting, the alternating current is reduced by transformers to 115 volts for commercial and private incandescent and arc lighting, and for power the current is distributed at 2,200 volts, alternating being in some cases used at this voltage and in others reduced to 460 or 230 volts for the driving of electric motors.

TRANSMISSION LINE.

The total length of the transmission line is 20.7 miles. It passes for a great part of the distance through a very rough and thickly wooded country, which made the construction especially difficult. A road was built along the whole length of the line over which the material was delivered. This road is now used by the patrol men who inspect the line. Many miles of wood road were built through the forest to the points where the trees were cut for making poles.

On the right of way there are two independent pole lines, about thirty-three feet apart, the poles on each line being spaced about 100 feet. On curves, angles and grades the distance between poles is less. The poles are about thirty-four feet long with tops not less than eight inches in diameter, and are set six feet or more in the ground. The butts are charred and tarred and the poles and cross arms well painted. For a distance of about one mile the line crosses a marsh, along the banks of the Tiete river. There the poles are braced on both sides.



Sao Paulo Tramway, Light & Power Company—Interior of Power House at Parnahyba, Showing Partial Installation

Each pole line carries three 3-phase circuits, the conductors being No. 0 copper wire. The conductors are so arranged as to form almost an equilateral triangle. Two cross-arms are used, the top arm carrying two conductors, 30 inches apart. On one line the cross-arms are braced with galvanized iron braces, on the other with wooden braces. Each pole line carries a metallic circuit telephone line, the wires being about five feet below the lower cross-arm. In the middle of the line there is a lightning arrester house.

SUB-STATION IN SAO PAULO.

The sub-station is located almost in the centre of the city of Sao Paulo. It is substantially built, the foundations being of concrete upon a close pile foundation, the piles being driven through the river mud to the hard sand strata below.

The transmission lines are led into the sub-station passing through a terminal room, in which are located the lightning arresters with their switches. The high voltage current of the transmission line is reduced through twelve air cooled transformers to 2,200 volts, and at this pressure distribution is made to the three switchboards, from which the current is again distributed to the street railway, lighting and power sections. For the street-railway there are now in operation three motor generator sets, each of 500 kilowatts capacity.

The electrical apparatus in the sub-station includes six 24,000 volt lightning arresters and switches ; high tension switchboard ; twelve 333 k.w. transformers, and low tension and induction motor switchboard. The latter contains four panels, each of which is for a bank of three transformers connected in delta for three phase circuits, a totalizing panel on which is recorded the output for the railway service and power service, two induction motor panels for the motors of the two railway motor-generator sets, and a compensator panel for controlling the starting compensator for these motors.

There are also in the sub-station three motor-generator sets, each consisting of a 700 h.p. induction motor driving a 500 k.w. generator at 400 revolutions per minute. The generators are the standard railway type, compound wound, giving 525 volts at no load and 575 volts at full load. The motor-generator sets are so arranged that they can be started from the direct current side through a starting rheostat as well as from the alternating side.

The direct-current railway switchboard contains two generator panels and five feeder panels, each of 1,200 amperes capacity.

The lighting switchboard contains a totalizing panel with recording instruments to record the output for the lighting service, and ten 200 k.w. feeder panels, each provided with a hand voltage regulator and an automatic overload circuit breaker. The regulator has capacity for varying the voltage ten per cent. above or below the normal voltage of 2,200. The feeders are single phase circuits, but each feeder may be connected by means of a three-way transfer switch on to any phase. In this way the lighting load can be distributed nearly equally on the three phases.

Sao Paulo Tramway, Light & Power Company Power House from Reservoir, Showing Head Gates, Feeder Pipe and Transmission Lines.

The power feeder switchboard contains five 500 k.w. feeder panels for three-phase circuits and 2,200 volts. Each circuit is provided with an automatic overload switch and circuit breaker.

POLES AND WIRING SYSTEM.

Leading from the sub-station there are three main trunk lines of feeders. There are in use three systems of poles and conductors. For most of the railway lines the overhead construction is supported on steel poles, but on certain suburban lines and on streets where a large number of wires for the lighting and power services of 2,200 volts are carried, wooden poles are used as being preferable for this distribution. The trolley wires are No. 0 B & S hard drawn copper, except on two long suburban lines, where No. 0000 B & S figure eight wire, having a mechanical clamping ear, is used. The feed wires are mostly of 500,000 circular mil cables.

Sao Paulo Tramway, Light & Power Company—Piers of Transmission Line Crossing Old River Bed.

For the lighting service in the central portion of the city where most of the business houses are located, the distribution is by an underground three-wire single phase system at 115 volts, fed from three distribution vaults, where transformers for transforming from 2,200 volts to 115 volts are located. In these vaults are switchboards and meters connected with the various underground circuits and also blowers for ventilating the underground system. The distribution to buildings is made through connections from the main underground feeders to an overhead system of sub-main which is run upon the facades of buildings. Connection is made between the sub-mains and feeders through switches, placed in cast iron junction boxes on the walls of buildings about every 300 feet along the streets.

In the portion of the city where the underground system is not used the distribution is on poles for the 2,200 volt conductors. Each main feeder supplies current to a large area or block in which the transformers are so located as to give a uniform voltage upon a three wire net work of secondary wiring at 115 volts. The neutral wire of all three wire systems is connected to earth.

In the central part of the city the power distribution is underground after the same manner as the lighting system. There is a three-phase 460 volt secondary fed from power circuit transformers located in the same vaults with the lighting transformers. For the rest of the city the distribution is by overhead feeders on poles in the form of three-phase current at 2,200 volts. For large size motors the feeder voltage will be used, but for small motors, 460 and 230 volts are used to suit each particular case.

TRACK CONSTRUCTION AND CAR EQUIPMENT.

The track for the electric railway has been laid in three types of rails, namely: 7-inch Girder rail weighing 92 pounds to the yard; 6-inch "T" rail weighing 62 pounds to the yard; and 5-inch "T" rail weighing 55 pounds to the yard. The Girder rail is of the well known Metropolitan type similar to that now used on Broadway, New York. The Tee rail is mostly laid on wooden ties spaced 2 feet 6 inches centres. The 5-inch Tee rail is used on some of the outlaying lines where road traffic is light, all the 5-inch rails being placed upon wooden sleepers.

Sao Paula Tramway, Light & Power Company—Construction of Track with Girder Rail.

The cars are equipped with 8-foot wheel base trucks of the Brill type, having 30-inch wheels. The motors used are from the General Electric Company, type G. E. 58, with K10 controllers. In addition to passenger cars, the company have several freight and mail cars.

Mr. L.L. Perry was the electrical engineer in charge of installation, while Mr. Harry Hartwell was the engineer for track and other construction.

The business of the Sao Paulo Tramway, Light & Power Company has been steadily increasing since its inception, and to meet the present and prospective demand for light and power an extension to the power house is now being built, in which a fifth turbine and generator will immediately be installed. During the past year six miles of primary and over eight miles of secondary wire were erected for lighting purposes, and seven miles of primary and four miles of secondary wires were added for power purposes.

There are registered on the books of the company 188 power customers, the number of motors installed being 279, aggregating 3,279 h.p. The number of lighting customers is 4,025, with a total of 33,019 lamps. The income from power last year was 35 per cent. greater than in 1903, while the lighting business showed an increase of 12½ per cent. The total gross earnings from all sources was $1,419,338, and the net profits $648,000.

Sao Paulo Tramway, Light & Power Company—Sub-Station at Sao Paulo.

Callender's Cable & Construction Company, Victoria Embankment, London, Eng., have sent us an artistic catalogue descriptive of their lead sheathed cables, which are made in accordance with the dimensions specified in the British Standard Tables.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Ques. No. 1.—If a short-circuit occurs between a direct current generator and motor, the short being between the fuses and the motor, I know that the motor will run as a generator and send a heavy current through the short as there is no fuse to open this circuit. If the system is alternating current, and connected the same way, what will happen? I have been told that an induction motor will run as a generator, but have tried this with a small machine and can't get any voltage or current out of it. Is there anything the matter with my machine?

Ans. No. 1.—What you say about the direct current machinery is correct, and this is the reason that the motor fuses should be placed as close to the machine they are supposed to be protecting as possible. The same action does not take place when an induction motor is short-circuited, however, owing to a peculiarity of this class of apparatus. If two induction motors are being run off one generator the highest possible speed of each motor will be synchronism, and this can be found by dividing the number of alternations by the number of poles on the induction motor. When the motors are running light, their speed will be practically synchronous, but when full load is applied, the speed will drop 3 to 7 per cent., according to the size and design of the machines. If both motors are running on one circuit, and if one be loaded, and the other be belted to some apparatus which is capable of driving it *above* synchronous speed, and by this means it is speeded up above this critical point, it will pump energy into the line, and the motor which is carrying a load will take part of its current from the generator and part from the other motor. From this is would appear that you could cut out the generator altogether and continue to run the one motor off the other, but such is not the case. Just as soon as the constant source of energy is removed, the motor which has been giving out current will cease this action, and the driven motor will come to rest. In other words, an induction motor will run as a generator only when it is connected to some source of energy and when its speed is above synchronism. Therefore, when you make a short-circuit between the motor and its fuses, this action immediately takes the voltage from the terminals of the motor, and it cannot act as a generator. A driven induction motor will not give either current or voltage by itself, and there is nothing the matter with the machine with which you tried the experiment.

Ques. No. 2.—Are the letters "I—T—E," used in connection with circuit-breakers, just a kind of trade mark, or do these letters mean anything?

Ans.—"I—T—E" is certainly a trade-mark, but it also has a very definite meaning. The letters are the initials of three words, namely, "inverse—time—element," and when used in connection with circuit-breakers indicate that the time taken by the breaker to open is inversely proportional to the amount of current in the circuit. In other words, if the breaker be set to open at 100 amperes, and it takes one second to open after this current commences to flow, then if a current of double this magnitude be made to pass through the instrument, the time required to open will be in inverse proportion, namely one-half second.

Ques No. 3.—How much current does an induction motor take when running without load?

Ans.—This will, of course, depend on the size and design of the motor in question. Generally speaking, at no load a machine of fair size, and constructed on good lines, will take from the circuit from 20 to 40 per cent. of the full load current. Of course, under such conditions, the power factor is extremely low, and therefore the number of watts being consumed will be low in proportion. If you will advise us of the make and size of the machine about which you require the information, we will be able to answer in a more satisfactory manner.

Ques. No. 4.—In figuring the efficiency of an alternating current generator, excited by a separate direct current exciter, how is the excitation current taken into consideration?

Ans.—If the efficiency test covers the alternator only, the watts input of the field is charged up as one of the losses, this input being measured by voltmeter and ammeter connected right at the field terminals. This test you will see does not include the loss in the generator field rheostat nor in the exciter itself, not yet in the exciter field rheostat. When the efficiency of an alternator is spoken of, a test as above is the basis of measurement. Where the "combined" efficiency of the machine and auxiliary apparatus is specified, all the losses mentioned above are to be included. If the exciter be driven by belt from the alternator shaft, the belt losses should be included. If driven by motor, the motor loss should be taken in. If driven by a steam engine the equivalent in watts of the indicated horse-power should be charged against the alternator. This "combined" test is rarely called for.

THE VANCOUVER POWER COMPANY'S PLANT.

In referring to the completion on April 27th of the tunnel of the Vancouver Power Company, Messrs. Hermon & Burwell, consulting engineers for the work, write the Electrical News as follows: "The closing error in alignment was only ⅞ of an inch and the error in the levels only 1¾ inches. Considering that it was necessary to run 21 miles of levels to get around from one portal to the other, this error of 1¾ inches is probably more surprising than the smaller error of ⅞ inches in the alignment."

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope o this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

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OUR VANCOUVER OFFICE.

The publishers of this Journal have recently established an office in Vancouver for the purpose of looking after more carefully the interests of subscribers and advertisers in British Columbia. This office is located at 536 Hastings Street, Suite 3, opposite Molson's Bank, and is in charge of Mr. G. A. Gall, who will be pleased to meet any of the friends of this Journal, and to serve their interests in any possible way.

Electric Pumping. The recent action of the Dominion Steel Company in connection with their pumping equipment on the Sidney River is worthy of note, particularly as the City of Montreal has, within the past month, rejected a proposition covering the installation of electrically driven pumps for the waterworks department, and decided in favor of steam. The dam of the Dominion Company at Sidney River is being materially improved, and with this matter the question of cheapening the cost of pumping has apparently received consideration also. The experience of this concern has been that steam pumping is a pretty expensive proposition, comparatively speaking, for during the past winter some six thousand tons of coal were consumed. The point has been brought out that the reason for the high cost of steam rests entirely with the fact that the cost of landing coal at this station is very high, but a matter of interest is that this Company should certainly be in a position to obtain the coal in the first place at an exceptionally favorable figure. Therefore, while the matter of coal transportation and handling may be excessive, the low first cost of the product should just about offset this difficulty, and we find that the cost per ton of the fuel, landed at the station, is not as high as one would be led to suppose. This Company generates its own power, and doubtless in large quantities; therefore the cost per kilowatt-hour may be and should be low. What distance this power has to be transmitted, is a subject upon which we have no definite information, but if the cost of transporting the coal is a serious matter, then it follows almost logically that the power transmission is of considerable length, and this will of course materially increase the cost of the electrical energy per unit delivered. We understand that this change from steam to electricity is one involving the expenditure of many thousands of dollars, and one may therefore be reasonably sure that before the decision was reached to make this outlay, the whole question of steam versus electrical pumping was gone into very thoroughly, and that the saving which the electrical system is expected to show must really be large to warrant the discarding of the existent equipment. It would be necessary to have more definite information in connection with this change to enable us to draw conclusions, but it is to be hoped that the proposition will work out satisfactorily and that the saving effected will instill confidence into the many companies and municipal corporations before which similar problems are continually being placed

Then we have the Montreal case. In this, the opinions of two experts were placed one against the other—and opinions differed. This was a municipal proposition, and such being influenced usually by conditions other than those which appear on the surface, it is a question whether the decision of the Montreal Council can be taken as a precedent. Mr. W. McLea Walbank, the First Vice-President of the Montreal Light, Heat, and Power Company, submitted a report to the Mayor, on behalf of his interests, and a contra report was prepared by Mr. George Janin, Superintendent of the Waterworks Department. Mr. Walbank's estimate, contrary to that of Mr. Janin, shows that electrical pumping would mean a material saving for the City. He points out that, working on a twenty hour basis, the cost of pumping a million gallons of water by steam, using, we presume, the best triple expansion condensing engines, will amount to $8.88, while with an electric pump, this figure can be reduced to $6, making a saving in the cost per million gallons of $2.88. The initial outlay required to install a twelve million gallon electric pump, Mr. Walbank states as $19,782, and he places against this the cost of a steam pump of similar capacity at the figure of $102,080. The yearly operating cost, working twenty hours per day, three hundred and sixty-five days per year, is given for the electrical system as $21,900, and for the steam as $32,440. As this is a matter of great interest, we give below the method of arriving at the the above costs :

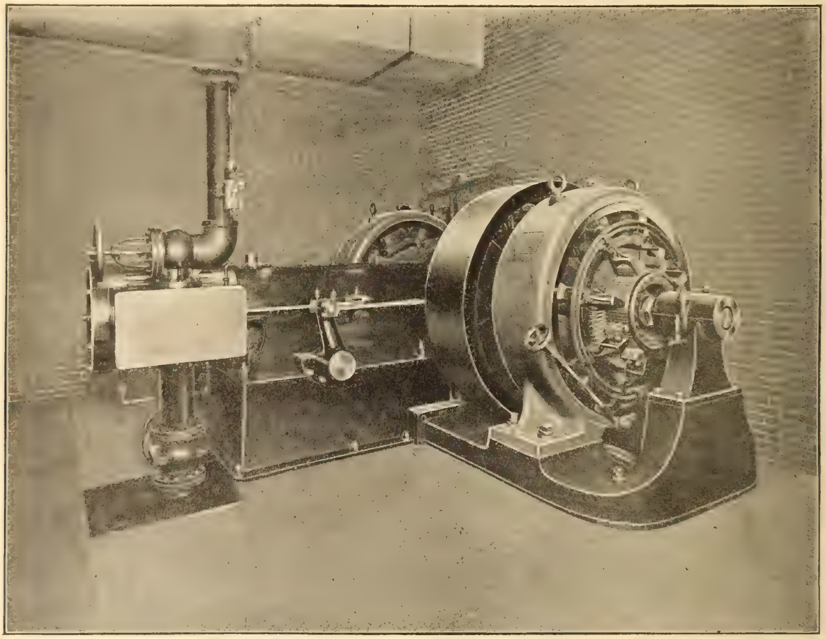
ITEM.	ELECTRIC.	STEAM.
Interest on investment, 4%	$791	$4,083
Depreciation, 5%	789	5,104
Labor	1,757	3,334
Repairs, (electric 1%) (steam 2%)	197	2,041
Coal, @ 4.50 per ton		14,207
Electric power @ $5 per million gals.	18,250	
Oil	50	400
Removal of ashes		1,272
Insurance	65	312
Boiler insurance		15
Coal for banking fires, loss by steam condensation, etc		1,420
Inspection of coal		250
Total	$21,899	$32,438

This places the cost of electric pumping almost 33 per cent. lower than the steam, and if the above figures have been accurately arrived at, then it would be interesting to know why the City of Montreal incurred additional and unnecessary expense by deciding upon steam. The low first cost of the electrical apparatus and pumps deserves careful consideration, and the practically indestructible nature of the centrifugal type of pump certainly merits favor. In fact the total cost was so low, comparatively speaking, that the saving effected by the electrical system was of sufficient magnitude to return the entire investment in less than two years. When the Montreal Light, Heat & Power Company was asked to submit a price for electrical energy per million gallons, working on a day basis of twenty-four hours, their figure, when received, was naturally higher than that for a twenty hour day. This was to be expected, for no doubt the twenty hour day would start at say 8 p.m. and end at 4 p.m., and thus the pumps would not be in operation during the peak load. Changing to a twenty-four day would make a world of difference, for this would undoubtedly mean the installation of additional powerhouse capacity, and instead of the load factor of the system being improved by the taking on of the electric pumps, the reverse might be the case, and hence it is readily understood why the Montreal Company wanted $7 instead of $5 for twenty-four hour pumping. So far as Montreal is concerned, working twenty-four hours lowers the cost of steam, and raises the cost of electricity. The revised figure for steam is $8.26 per million gallons, and $7.88 for electric. This brings the two pretty close together but still a saving is shown for the electrically driven pumps, and with this must be considered that a twenty-four hour day in any case is a very questionable duty. And then comes the report from Mr. Janin. Mr. Janin states that the cost of pumping by steam per million gallons on a twenty-four hour day basis, is 30 cents cheaper than electricity, and then goes on to point out that twenty-four hours is not the usual run according to the experience of the Waterworks Department, but that twenty hours is nearer the proper figure for this class of work. What the comparative costs are for a twenty hour day, according to Mr. Janin, is something upon which we have no data. However, the whole trend of his report seems to be that electrically driven pumps would have a much lower first cost, could be put in quicker, and that the character of the turbine pump itself was such as to warrant favorable consideration. Apparently, cost of operation is the point upon which Mr. Walbank and Mr. Janin differed, but the advantages of the electric over steam, which have apparently been acknowledged by both parties, should have been sufficient to make sure the adoption of the former. But as is usual in municipal deals, there were doubtless other considerations which the public in general will know nothing about, and these considerations were evidently of sufficient weight to swing the decision over to the side of steam driven pumps. Therefore, as we mentioned before, it is very questionable if the decision of the Montreal Council can be taken as a precedent.

There is another field for electrically driven turbine pumps, and that is fire service. Such a scheme is now being taken up by the City of Toronto, and a piping system to carry a pressure of three hundred pounds per square inch is to be laid throughout the congested business district. This system can be fed from two sources, namely, two steam turbine driven pumps, and two induction motor driven pumps. It is the intention to use the electrical apparatus for regular service, owing to its quick starting feature, for though the mains will be filled with water at all times, there will not be more than ordinary service pressure on, except when a fire alarm is received. Then one of the motors will be thrown in, and before the fire department can get hose lines laid the pressure through this special system can be brought up to the point previously named. The second motor is a reserve, and should the fire assume the magnitude of a conflagration the steam-driven apparatus can be called upon, either for additional capacity, or in case of the electric supply mains being destroyed. This matter has been very carefully worked out by the Engineering Department of the City of Toronto, and from the above rough outline of the system, it is easy to see that the men in charge are capable men, and that they will give the city a fire fighting system which there is every reason to believe will preclude the possibility of a reoccurrence of the disaster which visited the Queen City a year ago last April. Electric pumping for town and city water is unmistakably on the increase, for energy for this purpose can usually be obtained at very attractive figures. It is the peak load that bothers the lighting and power companies, and the more pronounced this peak the higher the cost per unit of energy generated. If a good pumping load can be turned over to such a company, it may mean salvation, for if there is one feature which appeals to the manager of a power plant it is a big steady all day load which can be thrown off when the lighting and power curves overlap. It is this kind of load which can be, and should be obtained from the electrically driven pumping station, and the almost universal satisfaction which has resulted in the past, assures the installation of many more such plants.

ELECTRIC PLANT OF THE NEW SCHOOL OF SCIENCE BUILDING.

The new building known as the "School of Mining and Chemistry," in connection with the School of Practical Science of the Toronto University, marks a decided step in advance in the teaching of scientific subjects to the coming generations of this province. It is equipped with most up-to-date appliances for demonstrating modern methods as well as for experimental and research operations. It may be inferred that an institution of this character, which is sending out as its graduates the future engineers who will take a prominent part in the development of the mining and power resources of our country, should teach thoroughly the latest methods of production and application of the power of the future—electricity. With that end in view the authorities decided to install a plant which would produce the current necessary for light and power in the building and would also allow the students to obtain a practical knowledge of the construction of the machinery and the production, handling and distribution of power.



Generating Plant in New School of Science Building, Toronto.

The contract for this installation was given to the Electrical Construction Company of London, Limited, one of the younger companies manufacturing electrical machinery, but one which is rapidly making a reputation in their line. It seems appropriate that this company should have supplied the machinery, as the managing director, Mr. E. I. Sifton, is one of the earlier graduates in electrical engineering of the School of Practical Science.

The fact that the contract was completed to the entire satisfaction of the engineers in charge shows that the experience obtained by the students of the School of Practical Science is of a high order when it enables a student to design and manufacture apparatus of this kind in such a manner as to obtain this contract in competition with the largest and best manufacturers in Canada and the United States.

The entire plant, upon completion, was subjected to a severe test under the supervision of consulting engineers, Messrs. Ross & Holgate, of Montreal, in conjunction with the professors in the electrical and mechanical branches of the School of Practical Science. The test comprised thorough inspection of all mechanical details and materials, together with operating the plant at various percentages of load ranging from friction load to nearly 50 per cent. over-load, taking readings and making calculations to show the efficiency, temperatures, regulation, overload capacity and general capability of the plant to perform the various duties which may be required of it.

It was further tested to a full load run of ten hours, immediately followed by two hours run at 25 per cent. over-load, and after proving satisfactory on this test was operated during an eighteen-hour run at full load.

The generators showed during this test that they could be operated from "no load" to 25 per cent. over-load without shifting of the brushes or employing any non-automatic device for any purpose whatever, thus showing the care which had been used in designing the generators so they would regulate themselves under varying conditions to which they will be subjected. Notwithstanding the severe test, there were absolutely no changes required or improvements suggested.

The plant itself is unique, consisting of two dynamos each of 75 kilowatts capacity, connected direct to one engine having a capacity of 300 horse-power. This is the first instance in Canada where two dynamos have been direct-connected to one engine.

The main switchboard, consisting of ten marble panels, each with its recording instruments, is probably the most complicated switchboard in use in Canada. In addition to the main switchboards, there are three panels, each one controlling a motor operating an exhaust fan in connection with the ventilating system.

Four additional panels are used, fitted with instruments to automatically control the temperature of each room throughout the building.

The reproduction of photos of engine, dynamos and main switchboard, together with a description of the use of each panel, will show how completely the plant is designed to obtain the results required of it.

Panels Nos. 1 and 2 control and indicate the total output of each machine, respectively, and consist of, for each dynamo:

Voltmeter—To indicate the pressure of the current.

Illuminated dial ammeter—To indicate the quantity of current being consumed.

Rheostat—To regulate the voltage.

Main switch, 600 amp. capacity—To connect dynamo service lines to their respective bus bars.

Six hundred amp. switch—To connect the bus bars to the five pole switch described under panel No. 3

Panel No. 3.—Ground detector—To test and ascertain if at any time any of the conducting wires either of the dynamos or lighting or power distribution services should become defective in insulation, showing contact with piping or other conducting material giving connection to the ground. Five pole double-throw, six hundred ampere switch, which when thrown in one position connects the two dynamos in parallel, and when thrown in the other direction connects the dynamo in series for the operation of three-wire service. Two other three-pole double-throw switches on this panel supply to the lighting distribution bus bars from either series or parallel connection and also allow connection with the city lighting service.

Panels 4 and 5 control each a 600 ampere service, and deliver the current to the mining department of the school, where it is used in electrical furnaces and other experimental work. Each panel is provided with an ammeter, a circuit breaker which automatically breaks the circuit if at any time carrying more current than the capacity for which it is set, also double throw switches allowing either panel to take the current from either dynamo or from both. One switch on this panel controls current to pilot lamps illuminating each panel of the board, and another connects motors through the building to the power service supplied from either the dynamos or the city circuit.

Panel 6 controls distribution of two services of three hundred ampere each to panel No. 10. Two ammeters indicate the amount of current from each service and six switches (interlocking) allow each service to be supplied from either or both dynamos or from city service. The interlocking device protects either service from being supplied by more than one service at any time. Each service is also protected by an automatic overload circuit breaker. A three pole switch on this panel forms the connection between city service and special distribution boards in the building.

Panels 7 and 8—Five special three pole fusible single throw switches supplying all the lighting service throughout the building, including the milling and engineering buildings. An ammeter on each panel indicates the amount of light being used.

Panel 9 controls through two double pole fused switches, two special service lines to the engineering building, the current used being indicated by two ammeters. A three pole fusible switch controls a three wire service for the Engineering building.

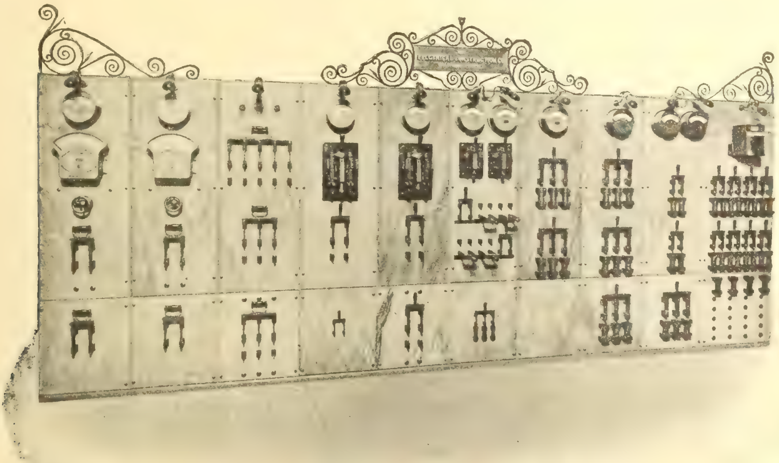
Panel 10 consists of eight fusible 300 amp. single-throw double-pole switches connected to various departments for special testing, demonstrating and laboratory work. These switches are supplied with current through a system of interchangeable flexible lead plug switches from three different sources through two service lines from the interlocking switches (panel No. 6), thus making a most flexible service capable of being obtained from many different sources through different channels.

A glass case recording wattmeter on this panel registers the amount of current which has been consumed from a source of supply other than the generating plant.

The entire switchboard of ten panels is surmounted by a neat iron grillework in which is set a panel bearing the name of the manufacturer, "The Electrical Construction Company, of London, Limited."

Three other panels control the operation of motors in the building, each panel having thereon an ammeter, automatic overload circuit breaker, and automatic speed controller.

All metal parts of instruments are finished in black oxidized copper, the board itself being polished and bevelled blue Vermont marble two inches in thickness.

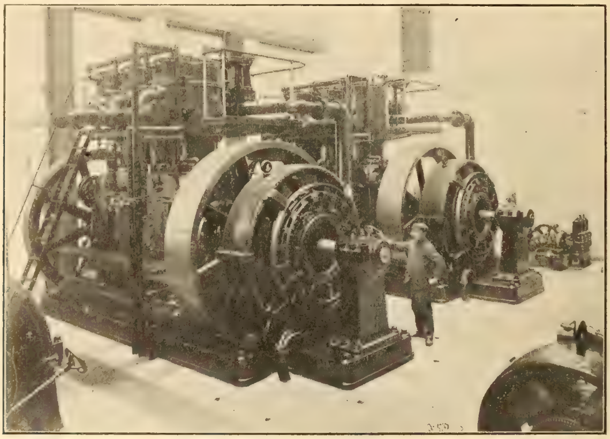

MAIN SWITCHBOARD IN NEW SCHOOL OF SCIENCE BUILDING, TORONTO.

THE POWER STATION OF WALTHAMSTOW, ENGLAND.

By Emile Guarini.

The Walthamstow Urban District Council's electric supply station is of a very interesting design. The works are situated conveniently near to the Great Eastern Railway. The main building includes a spacious machinery room, battery room, repair shop, stores, etc., the various offices being on the first floor, and coal shed adjoining the main building. Five feeders run from the station to the feeding points, from which current is distributed at 460 volts across the outers, and 230 at the consumers' terminals. The cables are laid on the solid system in earthenware troughs.

The public lighting consists of sixty-three arc lamps of 1,400 c.p. each, run in series nine across the outers of the three-wire network. Following the usual practice, two incandescent lamps are placed on each column. In many of the less important thoroughfares incandescent lamps have replaced gas, the old gas standards being converted for this purpose.



Westinghouse Gas Engines and Helios Generators, Walthamstow Station.

It appears that the equivalent of over 5,000 8-c.p. lamps has been connected, and applications have been received for 7,000 more. For energy for power purposes there is also some demand.

The power station comprises two Cudor batteries of 142 cells each, the capacity of the battery being 720 ampere-hours. A 10-ton derrick and Ritchie overhead travelling crane spans the engine room.

The main switchboard is of white marble, and has seven panels, together measuring 24 feet 6 inches long by 7 feet high. It is of the usual three-wire pattern, and is arranged for the connections of four dynamos, six feeders, two batteries, one balancer and two boosters. In addition to Weston ammeters and Kelvin voltmeters there is a Chamberlain and Hookham amperemeter for each dynamo, one for each booster, and a reversible one for each battery. There are also two hot-wire voltmeters to register the voltage at the feeding points and one for the station. There is also a station lighting and power distribution switchboard, consisting of three panels of white marble with the necessary fuses, switches, etc.

The generating sets consist of three Westinghouse gas engines direct coupled to Helios multipolar generators. The dynamos, contrary to the general practice with gas-driven plants, are coupled direct to the engines. They are shunt wound, and are rated to give 150 amperes at voltages varying between 460 and 560, and at a speed of 240 r.p.m., the regulation being entirely effected by altering the shunt resistances. The magnet frame is circular in shape, and is divided so that the top half can be removed if necessary for the inspection of the armature. The magnet poles are of soft steel bolted to the magnet frame, being set in position by a feather on the pole piece which slides into a groove in the magnet frame. The pole shoes are accurately bored out when in position. The field coils are machine wound on frames, which are held rigidly on the poles by the pole-shoes. The armature is of the slotted drum type. The core is built up of thin punched discs of Swedish charcoal iron mounted on a cast-iron spider, which is keyed to the shaft. Each disc is slotted to receive the windings and then shellaced and separated from the next by paper. The commutator is of hard drawn copper segments mounted on a cast-iron core and insulated from this and each other by mica. The position of the carbon brushes is adjustable by means of a hand wheel and worm gear. Ring type lubricators are used.

The gas engines are of the three-cylinder vertical type and each has a capacity of 110 horse power. The engines have three single acting cylinders working on the four-cycle principle. Each engine contains a mixing chamber, in which the gas and air are mixed in the required proportions. The supplies of air and gas are regulated by valves with hand adjustments, and the supply of the mixture to the engine is governed by a valve between the mixing chamber and the admission valves. This latter valve is controlled by a sensitive governor of the fly-ball type, and the governing arrangement ensures a maximum constant number of impulses to the engine, whatever may be the load. With this principle of governing it is obvious that there must be a great economy of fuel, as the amount of gas used is practically directly proportional to the engine load; an almost noiseless exhaust is also obtained. The engines are water jacketed, the water being used again and again, after having been sent from the cylinders to a cooling tower. The circulation is maintained by centrifugal pumps direct coupled to Helios motors; the pumps being in duplicate to ensure reliability in working. Compressed air is used to start the engines, and the ignition tubes are fired electrically, either by small sparking dynamos or primary batteries. All pipe work in the station is underground.

The gas used to drive the engines is produced by the usual Dowson method. The gas is generated as quickly as it can be consumed, but to ensure a steady pressure and to cover any fluctuation in the rate of production, it passes into a gas holder before going to the engines. Two gas generators are employed each capable of meeting a maximum call of 250 H.P. Each is supplied with cooling pipes, a hydraulic box, two coke scrubbers, a washer, and a sawdust scrubber. The production of gas is governed automatically to suit the varying rate of consumption. The cost of the gas works out to about 2½d. per 1,000 cubic feet, but as ordinary coal gas bulk for bulk goes four times as far as the producer variety the equivalent of 1,000 cubic feet of town gas costs about 10d. As the price of town gas at Walthamstow is 3s. 10d. per 1,000 cubic feet, there is little question which is cheaper. The fuel consumption in the engines is about one pound per horse power per hour; whereas with the best non-condensing steam engines it is from 2½ to 3 pounds of fuel per horse-power hour.

The balancer set consists of two four-pole machines coupled together with a flexible coupling. Each machine has an output of 20 k.w. at 230 to 250 volts, and is capable of dealing with an out-of-balance current of 100 amperes. The fields of the machines are cross connected to the opposite sides of the three-wire system. The two machines are started simultaneously by a double motor starter. A shunt regulator is inserted in each field. The boosters are of the same type as the balancers, and are coupled in the same manner. Each is capable of boosting a current of 230 amperes, or 300 amperes if necessary, from 10 to 130 volts. Shunt regulating resistances are inserted in the fields of the booster generators. The booster motors are driven from the bus bars at 460-900 volts. There is also a "milking booster," consisting of two 2-pole machines rated to give 200 amperes at any pressure from two to eight volts.

TORONTO BRANCH A. I. E. E.

FRIDAY, APRIL 14TH.

The eighteenth regular meeting of the Toronto Branch of the A.I.E.E. was held on Friday evening, April 14th, at the Engineers' Club Rooms, 96 King street west. Mr. F. O. Blackwell, consulting engineer of the Electrical Development Company, delivered an illustrated address upon "Niagara Power Development and Transmission", some notes of which appear elsewhere in this issue .Prior to the meeting an informal dinner of the local members of the Institute was held at the King Edward Hotel, at which Mr. Blackwell was a guest.

FRIDAY, APRIL 28TH.

The meeting on the above date was held in the School of Practicl Science, when Mr. F. J. Parkin gave an illustrated address upon the "Lighting and Power Equipment of the Canada Foundry Company's Shops, Toronto." Mr. Parkin dealt prinicipally with the application of electric motors to the driving of machine tools, and by means of stereopticon views showed a number of interesting installations.

The generator equipment of the Canada Foundry Company's shops includes one 200 k.w. generator direct connected to high speed engines, two 75 k.w. direct connected to triple expansion engines, and four 75 k.w. belted to two slow-speed engines and one high speed engine, to total generator capacity being 650 k. w. There are installed throughout the shops 150 motors ranging from 2 h. p. to 50 h. p., the total motor capacity being 2,066 h. p.

The installation of wires and motors was executed strictly in accordance with the rules of the Factory Mutual Fire Insurance Company, and is considered of very high order. Mr. Parkin said that all taps from main to arc lamps or motors where such taps are of smaller sectional area than the mains and where they are in a position difficult of access, are fused with Edison plugs or Noark fuses 50 per cent. greater than the carrying capacity of the wire as given in the Underwriters' rules, the idea being to have such fuses large enough to take care of a short circuit only, other fuses or circuit-breakers being provided in any easily accessible position to protect arc lamps or motors from ordinary overload. All arc lamps are provided with porcelain ceiling boards and in the structural shop there is employed a special arc lamp suspension cutting the lamp out of circuit while lowering for recarboning, with no moving or swing wires, the lamps being held in position by counter weight. Overhead room being required for air hoists and moving cranes, it was necessary to keep loose wires out of the way.

In the machine shop and boiler shop a three-wire power circuit for variable speed motors has been installed, while for other buildings using constant speed motors only one voltage has been provided, 230 volts. The installation includes 17 cranes, six being jib cranes and eleven travelling cranes, ranging from five to sixty tons. On the main hoist and auxiliary hoist a special coil is brought into service for opening the circuit breakers in cage of crane when the hoisting hook reaches a dangerous position. The same arrangement is used on the hydraulic press in the machine shop for cutting the motor out of circuit when reaching the finished position of the work, such as pressing locomotive wheels on axels. Mr. Parkin explained that the pressure required for this work is ten to twelve tons per inch.

In each building there have been installed marble switchboard panels and slate panels for each motor, the rheostat and circuit breaker being mounted thereon. The wiring from panels to motors is in conduit. The main power and lighting feeders from the power house to the various buildings are all run overhead and anchored at each building on iron structures insulated from same with Ohio brass insulators held in position by draw bolt. The main leads from generator to switchboard are through a cable runway and supported on shelving.

Mr. Parkin's address covered many interesting practical points and at the conclusion he was tendered a hearty vote of thanks.

The Toronto Branch of the Institute are making arrangements to visit in a body the power development works at Niagara Falls in the near future.

ELECTRICAL DEVELOPMENT AT NIAGARA FALLS.*

Mr. Blackwell, after giving a general outline of natural conditions as to difference of levels, etc., in connection with Niagara Falls, said that the actual efficient height was 130 ft., with a possible power development of approximately 3,000,000 horse power, or about 2,000,000 actual horse-power available for distribution ; that the conditions of Niagara made it the largest power site in the world, there being practically no variation summer or winter, due to the enormous pondage back of the falls, the drainage area being 150,000 square miles, about 60,000 square miles being lake.

The present completed developments take about 150,000 to 175,000 horse-power ; those under construction would amount to about 300,000 h.p., so that there would be about 450,000 h.p. under development, or about 22% of the flow of the river.

The first development, the Niagara Falls Hydraulic Power Co., obtains its power by means of a canal around the falls, which drops below the American side, and at present has an output of about 40,000 h.p. The franchise given to that company limits the width of the canal, but does not contain any restrictions as to the depth, so that the possibilities are practically unlimited.

The next development is the Niagara Falls Power Co., which obtain their supply from a canal about 6,000 to 8,000 ft. long. The first development is about 100,000 h.p., the second 120,000 h.p.

The next development is on the Canadian side, which is by far the most favorable for developing this power. The first of the Canadian plants, the Ontario Power Co., takes water through a conduit and discharges it below the falls. The present construction is laid out for 180,000 h.p. at the intake, and proposes to use three pipes, each being 18 ft. in diameter and 7,000 ft. long, each having a capacity of about 3,000 cubic feet per second, delivering to three sets of wheels, each of which will have a capacity of 10,000 h.p.

The next development is the Canadian Niagara Falls Power Co. As at present laid out it has a capacity of 110,000 h.p. in eleven units of 10,000 h.p. each.

The next is that of the Electrical Development Co., and is somewhat similar to the Canadian Niagara Falls Power Co., having a tunnel 1900 ft.

The most difficult condition to overcome is that of ice in the river, there being considerable of this in the spring, as well as anchor ice. The tail race of the Development Co. is, below the power house, divided into two wheel ways, one on each side of the wheel pits. The discharge is made on both sides, so that one-half the plant could be shut down and the other half left running. The tunnel is the largest excavation of the kind ever made, having a width of 23 ft. and a height of 26 ft., equal to four ordinary railroad tunnels. The original tunnel on the American side was 18 ft. wide and 21 ft. high. The tunnel of the Canadian Niagara Falls Power Co. is 19 ft. wide and 23 ft. high. The loss of head in the tunnel of the Electrical Development Co. is about 12 ft., whereas on the American side it is 30 ft., and in the tunnel of the Canadian Niagara Falls Power Co., it is estimated to be about 26 ft. The pipe of the Ontario Power Co. has a loss of head of about 25 ft. ; so that the Electrical Development Co. is decidedly the most efficient.

The tunnel is built on a grade of 5½ ft. to the 1,000, and the velocity is about 26 ft. per second, which is extremely high. In order to prevent erosion, it is first lined with concrete, with a hard, smooth, brick surface outside of that.

The original plants on the American side support their wheels on the sides of the wheel-pit, and the discharge leads into a single tunnel underneath, which has been the cause of some trouble.

The original wheel-pit on the American side was about 420 ft. long, that of the second American plant about 460 ft. The Canadian Niagara Falls wheel-pit, which has approximately the same power, is about 570 ft. long, the Electrical Development plant 460 ft. long, a great economy of space being obtained by the latter company, which has only one house-way for each pair of weeels and an inside house-way for each wheel.

The size of the power house and the cost of the plant is the same as it was on the American side for half the horse-power.

The weight of the entire revolving machine for the Electrical Development Co.'s plant is 280,000 lbs., this including machine shaft and parts of water wheel. The height of the wheel is 34 ft. and diameter 8 ft. ; the runways being about 3 ft. in diameter. The generators, being the largest ever built, have a capacity of 8,000 k.w. each. The main object sought for in the construction of the plant is to arrange so that no one accident can shut down the entire equipment. If any generator should go wrong, the automatic switches will cut it out, allowing the service to continue without interruption.

On the transmission line there are four circuits controlled from high tension oil switches, so that if any one of the lines should become short-circuited, it will hold in the other circuit breakers and cut itself out, so that the system can go on without short circuit or interruption of the service.

The transformers are in banks of three—each of 2700 k. w. capacity, so that each bank is the same capacity as the generator.

The auxiliaries are connected to the bus bar, and the exciters can be run from either water wheels or motor generators, there being three units at commencement and eventually four of these, so that any of the exciters can be shut down without interrupting the service, each pair being large enough to run the entire plant of 11 units.

Every wire in the system is separated from each other wire by fireproof compartment ; the switches are all separated by closed compartments and the bus bars are closed in the same way.

All the instruments are on transformers, each transformer in its own pocket. The cables connecting the power house with transformer house are run in separate conduits, of which there are three, and any two of these will run the entire system.

The current which would result in short circuiting any one of these enormous plants would be something like ten times the full load current of the generator, which in this plant would be an equivalent of about 1,000,-

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*Notes from an address by Mr. F. O. Blackwell, of New York, at a meeting of the Canadian Branch of the American Institute of Electrical Engineers, held at 76 King St. W., Toronto, Friday, April 14, 1905.

000 h.p. This extremely heavy overload of current is due to the fact that it takes a considerable period to back down the current of the armature of generator. Every generator has some of these characteristics, and it is absolutely essential for the switches to take care of enormous overloads. The advance that has been made in handling electric power is very great in this respect.

In connection with one of the installations in New York, a short circuit occurred in one of the sub-ways, which tore the whole street up and threw the iron casting of the man-hole 10 or 12 ft. in the air and broke it to pieces, notwithstanding which the oil switch opened and the circuit was not hurt.

The loss in line of the Electrical Development plant is about 5%, and the entire power can be transmitted with half the transmission line.

CANADIAN ELECTRICAL ASSOCIATION.

The arrangements for the Annual Convention in Montreal, June 21st, 22nd and 23rd next, are rapidly approaching completion. Following are some of the papers already arranged for :

"Transformers," by Mr. R. T. MacKeen, Canadian General Electric Co., Toronto.

"Operation of Transformers at Varying Frequencies and Voltages," by M. A. Sammett, Montreal Light, Heat and Power Co.

"Induction Motors," by Mr. Burson, Allis-Chalmers-Bullock Co., Montreal.

"Economy of Isolated Plants," by Mr. K. L. Aitken, Consulting Electrical Engineer, Toronto.

"Carrying Capacity of Enclosed Conductors," by Prof. R. B. Owens, McGill University.

Some additional papers are also promised.

The Question Box under the able direction of Mr. A. A. Dion, of Ottawa, will of itself be a feature of great value.

Among the other features arranged for are a luncheon at the Allis-Chalmers-Bullock Company's Works, a Smoking Concert and visits to the various sub-stations of the Montreal Light, Heat & Power Co.

A trip to Shawinigan is also under consideration.

The Laboratories of McGill University will be open to inspection by the delegates during the convention.

The Committee under whose direction the local arrangements are being made is composed of the following gentlemen : Messrs. H. D. Bayne, Canadian Westinghouse Co., (chairman) ; R. E. T. Pringle ; Prof. R. B. Owens ; H. J. Fuller (The Fairbanks Co.); C. F. Sise, jr., Asst. Superintendent Bell Telephone Co. ; Edgar McDougall (Caledonian Iron Works) ; Ed. F. Sise, manager Wire and Cable Co.; R. S. Kelsch, Consulting Engineer ; Wallace C. Johnson (Shawingan Water & Power Co.) ; W. F. Dean (Canadian General Electric Co.) ; Alfred Collyer (Allis-Chalmers-Bullock; E. F. Sise (manager Wire and Cable Co).

The complete programme will be printed in our Convention Number to be published early in June.

This meeting in Montreal promises to be a record breaker, and it will be to the interest of every progressive electrical man in Canada to be there.

The Windsor, Essex and Lakeshore Electric Railway Company, of which Mr. Philip Heseltine, of Detroit, is manager, expect to let the contract for their road at an early date. The road will be operated on the high tension single phase alternating current system and is expected to cost upwards of $2,000,000.

BRITISH COLUMBIA ELECTRICAL MATTERS.

Mr. J. Buntzen, for several years manager of the British Columbia Electric Railway Company, returned from England early in April, and made the announcement that the directors of that company had unanimously authorized the expenditure of $120,000 for the electrification of the Lulu Island Railway between Vancouver and Steveston, a distance of 17 miles, also that $60,000 was appropriated for the relaying of tram tracks. The company have therefore made arrangements for actively prosecuting the work on the Lulu Island road. The contract for the wire has been awarded to Mr. Frank Darling, representing the Eugene Phillips Electrical Works, of Montreal, which contract calls for 106 miles of wire. To guy the poles and make them absolutely secure will require at least ten miles of guy wire, while for the telephone service, which is to be a part of the system, about 70 miles of wire will be required. The single pole type of construction will be used, which will demand 1,500 cedar poles, 3,000 cross arms, 10,000 pins and 10,000 insulators.

The Canadian General Electric Company will supply the electrical apparatus and equipment, including the car motors. The B. C. Electric Railway Company are now building in their shops three cars for use on the line, which will cost $9,000 each. They will be of the large inter-urban type, mounted on trucks from the works of J. G. Brill & Company, of Philadelphia, and equipped with air brakes by the Canada Foundry Company, of Toronto, also with the Sterling safety hand brake as an auxiliary. Each car will be provided with a portable telephone instrument, so that any break-down may be reported at once.

The contract for the sub-station at Eburne has been awarded to Messrs. Ironsides, Rannie & Campbell. This station will be 50 x 60 feet, of brick and concrete construction, and will be similar in design and equipment to the station at Burnaby, on the Westminster tram line. It is the intention of the management that the Lulu Island road shall be a model system in every respect. Mr. Buntzen has just accepted the highest position in the gift of the company, namely, that of managing director. Hereafter he will reside in London, spending three months each year in British Columbia. Mr. R. H. Sperling, who has been electrical superintendent under Mr. Buntzen, has been promoted to the position of general manager, while Mr. Frederick Hoffmeister, formerly of Vancouver, but who has recently been in Winnipeg, succeeds Mr. Sperling as electrical superintendent.

One of the most important openings for the investment of capital in British Columbia is likely to present itself this year in the suplying of electrical power to the smelters, mills and mines of Kootenay and Yale districts. The demand is growing, and the West Kootenay Power and Light Company are making a bold bid to control the industry by putting in a 25,000 horse power plant on the Kootenay River. The only rivers in the country which have sufficient water and sufficient fall to enable the economical erection of a power plant are, in the order of importance, the Columbia, near Meyers Falls; the Kootenay, below Nelson; the Pend d'Oreille, near Waneta, and the Kettle River, fourteen miles above Grand Forks.

The Columbia, between the outlet of Lower Arrow Lake and Waneta, on the international boundary, has too little fall to enable economy of construction. Next comes the Kootenay River, over the water rights of which a fight is now going on. Next the Pend d'Oreille, which is controlled by a grant from the State of Washington in the hands of Sir Charles Ross, a principal of the West Kootenay Power Company. Finally the Kettle River, which has only water sufficient to generate 5,000 horse power, and which on two occasions this year fell below even that capacity. It is probable, therefore, that the West Kootenay Power & Light Company will be able to produce power so cheaply as to shut out competition.

On Thursday evening, April 27th, after two years and four months of almost constant drilling and blasting, the Vancouver Power Company's tunnel between Lakes Coquitlam and Beautiful was completed. This marks an important step in the development of the hydro-electric power scheme which is ultimately intended to develop 30,000 horse power for distribution in Vancouver, New Westminster and Steveston. It is also a triumph of modern engineering, as a few condensed facts about the tunnel will show.

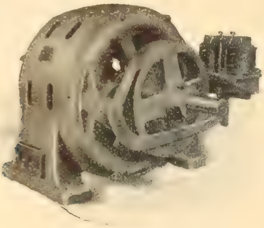
The total cost of the undertaking was $320,000, and the distance is about two and a half miles. The size of the tunnel is 9 x 9 feet, with rounded corners; area of normal cross section, 73 square feet ; number of men employed on construction, 100 to 175; average rate of progress per day, between 15 and 16 feet; explosives required, over 200 tons of dynamite, gelegnite and blasting gelatine; fuse used in blasting, 500,000 feet, or nearly 100 miles; candles required to light the work, 175,000.

Messrs. J. Buntzen, managing director, and R. H. Sperling, general manager, have expressed themselves as greatly pleased with the manner in which the work has been accomplished. Work was commenced simultaneously at each end; the two ends fitted exactly, and did not seem to be a quarter of an inch out. We understand that 13 holes were drilled in the last piece of rock and extra charges placed in the holes to make a sure job.

The engineers for the work were Messrs. Hermon & Burwell, while the contract was executed by Messrs. Ironsides, Rannie & Campbell.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

New Alternating-Current Solenoid Brake Applied to Induction Motors.—The accompanying illustration shows a new set for crane or intermittent service, developed by the General Electric Company, Schenectady, N. Y. The apparatus comprises a fifty-horse-power motor for crane service, and a new alternating-current solenoid brake. These sets are now in use on many large plants, among which may be mentioned the following: Great Northern Railroad shops, St. Paul, Minn.; Edison Illuminating Company, Detroit, Mich.; Canadian Copper Company, Copper Cliff, Ontario; Canadian Pacific Railroad, Winnipeg shops. For some time the utility of the induction motor has been handicapped for crane service for the reason that no electric brake had been developed for alternating currents which would operate successfully under all working conditions. This new line of brakes has been built for various potentials and frequencies in four sizes, to be used with motors rated from one to seventy-five horse-power. The magnetizing power is small and remains practically the same for all sizes. The momentary input at the full air-gap, which is governed by the type of brake, varies approximately in proportion to the weight of the movable core. The actual power required to operate the magnet is practically negligible. The solenoid works almost instantaneously, and the power consumed is required only for a moment. The power required to operate the brake thus amounts practically to the magnetization only, which is the power consumed by the solenoid when the motor is in operation. In tests made upon nine cranes operated by this General Electric induction motor and solenoid brake set, at the Great Northern Railroad shops, the switchboard ammeters at no time indicated any increase of current when the brake operated, neither was there any noticeable shock on the generators or engines.

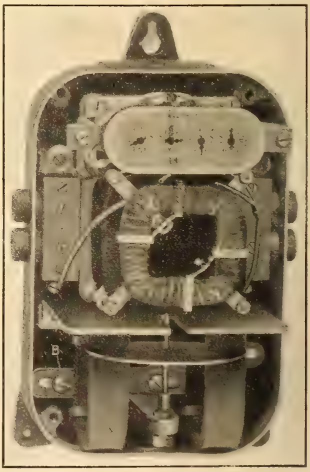


Induction Motor Equipped with Solenoid Alternating-Current Brake.

Westinghouse Direct Curtent Integrating Wattmeter.—Integrating wattmeters for alternating current service have been made by the Westinghouse Electric & Manufacturing Company since such insruments were first introduced, and the characteristics of the Westinghouse type have become very generally known. The announcement, therefore, that this company has developed a direct current integrating wattmeter which contains many of the special features found in the alternating current type and is constructed with the same regard to long continued accuracy, strength, durability and convenience in installation, will fix the position of the new meter in the first rank, and give a definite idea to meter users as to its value.

In general appearance the new instrument resembles the Westinghouse alternating current integrating wattmeters. The case is finished in black enamel, with letters in low relief. The terminals enter at the sides, passing through the case, the line wires being connected on the right hand side of the meter and the load wires on the left, the upper wire line being the positive. To make connections, it is only necessary to bare the ends of the wires, to insert them in the bushings at the sides of the case and to tighten the binding screws. The bushings form a close junction with the terminal blocks, and make the case as insect and moisture proof at this point as at all others.

By removing the cover, as shown in the illustration, all parts of the mechanism are exposed. The adjustments, which are wholly mechanical and do not depend upon variable resistance or similar arrangements, can then be easily made. To compensate for friction, the shunt coil shown at A in illustration is moved in or out, this coil being held in position by two screws which clamp against brackets as shown.



Westinghouse D. C. Integrating Wattmeter with Face Removed.

The speed of the disc is controlled by two permanent magnets, so mounted as to secure perfect alignment. Moving the magnets in from the edge of the disc increases the speed, and moving them out toward the edge decreases the speed, at any given load. Releasing the adjusting screws, one of which is shown at B, permits the magnets to be moved as required.

The lower bearing of the shaft is of the cup-and-ball type, the same as that used in Westinghouse integrating wattmeters for alternating current. The shaft terminates in a removable sleeve with a slightly cupped sapphire jewel, which rests on a hardened steel ball 1/16 inch in diameter. This ball is supported by a second jewel, similarly cupped, which is set in the end of the adjusting screw which forms the lower half of the bearing. The lower jewel is spring mounted, a construction which effectually protects it against sudden jar. The steel balls and jewels undergo a special polishing process and are rigidly inspected before using.

The very slight friction of a bearing of this form, which is much less than that of any heretofore devised, insures the meter remaining in calibration at light loads longer than is possible with a bearing of any other type, and this feature, combined with the reduced weight of the moving element, affords a longer period ot active service for this meter than for others.

The commutator is an important part of all direct current wattmeters, and requires the use of non-oxidizing metal and a diameter small enough to minimize friction. Especial attention has been given to this feature and it has been fully developed in every respect, the diameter being only 5/64 of an inch, which insures a reduction of friction to a minimum.

A perfect commutator is ineffective, however, without suitable brushes, so this feature has been made a subject of special study. Perfect contact with the least amount of friction must be maintained, and the material must be such that oxidization will not take place. The brushes in this meter are composed of a number of strands of wire of non-oxidizing material. This subdivision of the brush gives an excellent contact, as each strand is thereby made a separate brush and the series of strands conform exactly to the surface of the commutator with less total tension, insuring ideal working conditions.

THE HIGH VOLTAGE INCANDESCENT LAMP.

The development of the 220 volt incandescent lamp has not effected the changes in central station practice in this country that were generally expected when its advent was first announced. Most stations of small size, says the American Electrician, continue to use 110 volt to 120 lamps, employing three-wire distribution when distance makes two wire circuits impractical, and all of the large stations of which we have knowledge, excepting the one in San Francisco, use the three wire system for all direct current incandescent lighting. The prime reason for the continuance of the 110-220 volt, three wire distribution by the big stations is obvious ; their underground mains are all laid that way and the cost of changing over would be prohibitive, even if the high voltage lamp justified it otherwise. In smaller stations, however, the reason for not changing over is not so immediately apparent. The high efficiency 220 volt 16 c.p. lamp takes only 60 watts, as compared with 50 watts for the same class of 110 volt lamp, and it would seem that the saving in copper and balancing apparatus would compensate for the difference in the economies of the two lamps. In actual practice, however, we doubt that this would be true in any considerable percentage of cases.

A rough idea may be obtained by considering the chief differences between a plant having a 500 k.w. lighting load peak, using 110 volt lamps on a three wire distribution system, and a plant of the same lamp load using 220 volt two wire distribution. Assuming in both cases that the peak covers two hours, that the average load during the remainder of the 24 hours is 16 per cent. of the peak load, and that 85 per cent. of the lighting load is in incandescent lamps—which assumptions are as favorable to the high voltage lamp as one could reasonably expect—we get the following approximate data. The incandescent part of the peak load will be 425 kilowatts or 8,500 lamps ; the average during 22 hours of each day will be 85 kilowatts, or 1700 lamps ; the generating plant must have a maximum capacity of 500 kilowatts and balancing apparatus of about 50 kilowatts capacity will be required. If the distribution mains contain $17,000 worth of copper devoted to the lamps alone, about $4,000 of this will be in the neutral conductors. The generating plant, steam and electrical, at $110 per kilowatt will cost $55,000, and the balancing apparatus, involving no steam apparatus, will cost about $1,000 installed. At a cost of 2 cents per kilowatt hour for energy at the switchboard during the peak and 4 cents during the remainder of the 24 hours, the current operating cost will be $85 per day of 24 hours. The interest and depreciation on the balancing apparatus and neutral conductors will be at least $400 per annum—say $1.10 per day ; that on the remainder of the station apparatus will be about $6,000 per annum—say $16.40 per day. The items mentioned will foot up to $102.50 per day.

On the foregoing basis, the two-wire 220 volt plant will have a peak load of 585 kilowatts, and an average load for 22 hours of 97.5 kilowatts, owing to the difference in lamp efficiency, and the operating cost will be $109.20 per day. The interest and depreciation on the generating plant will be about $6,500 per annum, or $1.75 per day, making the total charges under consideration $110.95 per day, as compared with $102.50 in the other case. These, of course, are not all of the factors to be considered ; they are the principal ones, however, and this rough comparison indicates that conditions would have to be extremely favorable to the high-voltage lamp in order to justify its use to the exclusion of the lower voltage lamp. If the cost of the copper in the neutral conductors were very much higher per lamp of load, if the cost of the balancing apparatus were greatly above that assumed above, relatively, and if the operating cost were lower, then there might be a better prospect for the 220 volt lamp.

There is no doubt that many three-wire plants find the 220 volt lamp very convenient for use in outlying and scattered districts where the load is not large and the cost of the neutral conductors would be disproportionate. This class of load does not constitute a sufficiently large percentage of the total station load to affect the cost of current supply appreciably. We are more and more firmly convinced, however, that the solution of the problem of low-potential distribution lies, not in the abolition of the three wire system nor in jumping from 110 or 115 volts at the lamps to twice that e.m.f., but in raising the wire-to-wire voltage to the point where the over-all voltage of a three wire system will be the limit allowed by the Underwriters, namely, 300 volts ; 150 volt lamps are more practical than 220 volt lamps, and the former voltage is much more manageable in small devices, such as lamp sockets, receptacles, etc.

ENGINEERING and MECHANICS

THE PURIFICATION OF WASTE LUBRICATING OIL.

BY F. H. DAVIES.

The purification or filtering of lubricating oil is one of those minor engineering economies that are so easy to make and tend so much in the long run to the reduction of costs. Considering the price of oil and the proportion that it bears to total works costs, one might expect that few would be found to dispute its utility; and yet the small outlay that is entailed by the installation of some suitable device to deal with dirty oil is often deemed unwarrantable or not absolutely necessary, with the result that an entirely preventable waste goes on that in a short time costs much more than the apparatus that would have obviated it.

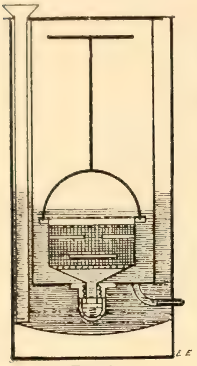


FIG. 1.

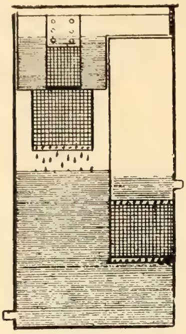


FIG. 2.

Doubtless much of this apathy on the part of some power users has been encouraged by the introduction of the self-oiling bearing, which, if large enough, to a great extent acts as its own purifier by a settling process. But such bearings become dirty in time, and in any case they only form a small portion of the lubricated surfaces in power installations using engines; consequently all the oil that finds its way from drip and siphon lubricators to the crankpits, etc., is absolutely lost, although perhaps quite fit for further use but for a little dirt that may easily be eradicated. In all but the largest installations the subject is a small one, hence it is often overlooked; but as it is obvious that in practically every case purification of waste oil must have an appreciable bearing upon economy, it follows that suitable apparatus for effecting it should always be provided and considered as of equal importance in its own sphere to any other saving device.

The impurities found in waste oil are often very numerous and different in their nature. They may be roughly divided into two heads—chemical and mechanical, and according to which class they belong, so the means for eradicating them will differ. Chemical impurities must be treated chemically, while those of the second class may in all cases be removed by filtration in one or more of its several forms. Oil that is exposed for a long period to the heat of an enclosed engine crank chamber will often become charged with fatty acids consequent upon decomposition, and, needless to say, their presence is always highly undesirable, and may even become dangerous. Filtration will not remove them, but treatment with an alkaline solution has been found very effective. The extraction of mechanical impurities as performed in filters may be either by the action of settling, with or without agitation; siphoning, in conjunction with subsequent settling; percolation, or various combinations of the three. The former—viz., settling without agitation—is the simplest, as the apparatus consists only of a large and deep tank, to the bottom of which the impurities sink by their own weight; but purification by this means, although effective, is a somewhat lengthy process, and one that may be down a pipe, the end of which is immersed in water kept warm by the steam heating device placed beneath in a separate chamber. Many of the larger impurities immediately sink to the bottom, others are thrown out by agitation or the rapid rise of the oil through the water (represented in all the figures by broken lines), and the whole of the time the oil is in this compartment settling is gradually proceeding. When the oil (shown in unbroken lines) reaches the top of the centre pipe, it wells over, falling into the funnel-shaped receptacle in the lower compartment. Its head—exaggerated in the figure—easily upset by careless handling of the apparatus in adding or withdrawing oil.

Fig. 1 represents in diagram a filter of this class, adapted for greater speed and convenience of working by the addition of the agitation principle, combined with a heating arrangement. It will be noticed here that after passing through the first strainer that removes all large impurities the oil sinks forces it down the pipe, and it emerges in drops at the bottom, passing through cold water and a perforated plate that serves to lengthen its path to the body of pure oil floating on the water. The remaining impurities now settle out, and the oil at the surface is clean and ready for drawing off by aid of the top cock, the bottom one being used for withdrawing the water and for cleansing purposes.

Fig. 2 shows a thoroughly good modern filter, in which the percolating principle is used in addition to that of settling by agitation. The dirty oil is poured into the upper tray, and, passing through the filtering material, in this case cotton waste enclosed in a metal strainer, drips into the receptacle surrounding the perforated head of the down pipe. As in Fig. 1, it emerges from the bottom and is distributed through the water (heated by a steam coil at the base), shaking out the remaining impurities, and rising to the top, where it is drawn off. Many filtering agents have been tried in oil purifiers, blotting paper, meat rags, felt, and other like substances; but waste seems to be most generally used, as for a given cleaning power it allows of the greatest speed of operation. Blotting paper is a thoroughly good material from the filtering point of view, but it gets very rotten, and is, on the whole, more expensive than waste, and needs more careful packing.

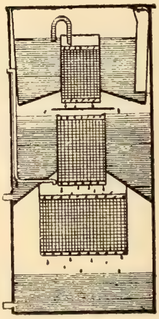


FIG. 3.

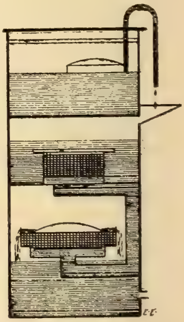


FIG. 4.

The filter shown is Fig 3 is similar to Fig. 2 in that percolation and settling with agitation are both used and accelerated by means of heat, but the processes are reversed, the former coming after the latter. Such a filter would effect the desired end of purification very well, but its action would be slower than that of Fig. 2, since the latter provides a much greater weight of oil on the filtering substance than is represented by the comparatively small quantity contained in the down pipe of Fig. 3. Unless this pipe is always kept more or less full, according to the quantity of pure oil in the upper chamber, the filter obviously will not work. In this latter respect the filter shown in Fig. 4 is an improvement, as there is always a greater store of comparatively dirty oil forcing its way through the filtering pad, situated as shown on the left-hand side of the inner vessel.

The two processes of agitation and percolation are repeated in the same order as in Fig. 3, and a disc is provided at the foot of the pipe to lengthen the path of the oil through the water, which is not heated. The small pipe on the left-hand side allows air to escape from the inner chamber as the oil rises in it, and those on the right communicate with the clean oil and draining cocks respectively.

The remaining four figures show modern methods of oil purification that dispense altogether with the agitation principle, adhering only to filtration pure and simple and the ordinary process of settling. Fig. 5 shows some novel and ingenious points. The dirty oil is poured into the funnel and fills the outer chamber, passing from thence through a valve into the bottom of the container holding the filtering substance. By virtue of the head it now rises through this, following a tortuous course between the plates, so placed as to secure a long path. It rises from the top of the filtering bucket and flows into the inner vessel, from which it is drawn as wanted through the pipe on the right-hand side. The chief novelty of the apparatus lies in the automatic valve, into the case of which the filter bucket is screwed by aid of the handle shown. In the absence of the bucket the valve is kept closed by the spring at the bottom, and hence the former may be taken out for cleaning or repair without emptying the oil from either the inner or outer containers. When the bucket is replaced the act of screwing it down opens the valve without allowing the two oils to mix, and permits the filtering process to go on as before.

Fig. 6 shows a three-stage filtration method, combined with settling processes in the first and second stages. The top chamber containing the first filter is removable, so that water and large refuse may be cleaned out frequently. The course of the oil is through the holes in the upper part of the first cylinder, and from thence through both filters to the large settling chamber, where most of the impurities deposit out. It then rises through the bottom of the third cylinder into the pure oil vessel, which is fitted with a cock. As the first two filters are only meant to deal with the larger impurities they are lightly packed and should be frequently cleansed, but the last stage requires better and tighter packing, and in view of the settling action that takes place before it is reached, less cleaning.

Fig. 7 shows another three-stage filter, of different construction but based on the same idea of settling processes in the first and second stages. It is, however, primarily different, in that siphoning is introduced prior to the first filtering, replacing the perforated cylinder arrangement. On emerging from the bottom of this stage, the oil passes through outlet tubes and falls into the second compartment, where it settles, and rises over the top of the second filter, pursuing its course straight through the third, and arriving at the bottom receiver in a purified state. The filtration by this method is most complete and the apparatus will deal with the dirtiest of oil.

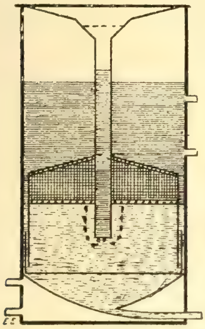


FIG. 5.

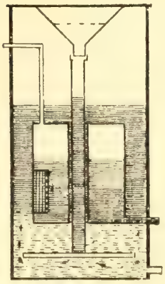


FIG. 6.

Fig. 8 represents a well-known and efficient filter, in which the first or settling stage is followed by a double percolation process. The floating siphon, shown in the upper compartment, is a good feature, as by this means, despite the level of the oil, only that on the very surface is passed to the filtering pads. The oil enters on the periphery of that in the first chamber, and, passing through, emerges into a channel that conducts it to the underneath side of the second pad, from the top of which it flows over to the lower or pure-oil chamber.

Other methods of waste oil purification are based on capillary and centrifugal actions, the former consisting of arrangements of siphoning wicks that naturally will not allow impurities to pass. In this respect they are very effective, but by far too slow for the average works requirements. The centrifugal method is good in that it gets rid of the dirt quickly and thoroughly, but it takes some power, and is rather costly when used on a small scale. On the whole there is nothing to beat a good filter built on scientific and common-sense lines. The material through which the oil percolates should be cheap, and so placed as to render renewal both easy and quick, and the whole apparatus should come to pieces so that it may be inspected and cleaned with facility. This type of filter should be so arranged as to make the later stages independent within a reasonable amount of the dirty oil fed into the first strainer—that is, they should always hold a good reserve—and it is important that the process of filtration should not be forced by continual filling up and working at full capacity. In the same way, the settling type of filter works best at light load, and will only give poor results when supplied with too large a quantity at once.—*Contract Journal.*

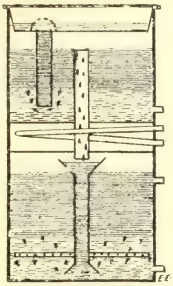


FIG. 7.

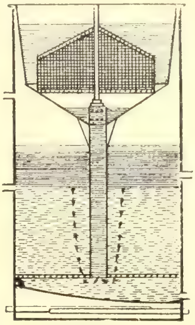


FIG. 8.

DEFECTS IN STEAM BOILERS.

One of the largest casualty companies reports the following list of defects, by classes, in steam boilers, found by its inspectors during the year 1904:

	Total Number.	Dangerous.
Deposits of sediment	833	117
Incrustation and scale	2,070	215
Internal corrosion	1,038	61
External corrosion	1,484	95
Pitting	1,617	45
Internal grooving	230	7
Leaking tube ends	1,275	438
Furnaces out of shape	845	177
Fractures	1,039	205
Water gauges out of order	471	150
Safety valves out of order	290	109
Pressure gauges out of order	509	123
Broken braces and stays	611	375
Bulges, sags or bags	938	136
Unclassified defects	2,793	462
	16,043	2,715

The failure of steam valves of cast iron was discussed recently at some length in "Le Genie Civil" by Mr. Sylvain Perisse, who gave an account of an accident which happened in an electric station in Paris. The valve in question was 12.6 in. from the top of a 6.3-in. vertical pipe, which was joined at the upper end into a horizontal main steam pipe 11.8 in. in diameter. Drain cocks were provided in the main pipe, but there was sufficient space above the valve to hold 1.43 gal. of water. When the accident happened the valve had been closed for eight hours and although the valve was opened very gradually, rupture ensued. In explanation of the failure, it was argued that the cause might be traced to the liberation of energy by the rapid expansion allowed on opening the valve. The author's conclusion was that a small by-pass should be fitted to all valves on a vertical or an inclined steam pipe.

DIAGRAM FOR POWER PIPES.

The accompanying diagram was prepared to facilitate the determination of the maximum horse-power obtainable from water under different heads flowing through pipes of different diameters. It also shows the quantity and velocity of the discharge, The horse-power is taken equal to a constant multiplied by the water discharge, multiplied by the pressure head, or horse-power $= kQp$. The formula, $V = \sqrt{RS}$, is used for the velocity. A constant diameter and a constant length of pipe are assumed for any particular case; so S varies as the head, and the value of the velocity may be obtained from the equation, $V = d\sqrt{h}$, where d is a constant and h is the head overcoming friction and causing discharge. The quantity discharged in any particular case equals the velocity multiplied by a constant, that is, $Q = a\sqrt{h}$, a including d, and the cross-sectional area of the pipe.

Substituting this value in the assumed equation for the horse-power, horse-power $= kap\sqrt{h}$. The pressure head equals the static head less the head causing discharge, or $p = H - h$, and a single constant, b, may be substituted for a and k. Then the horse-power $= b\,(H\sqrt{h} - \sqrt{h^3})$. Differentiating this equation with regard to the variable h and considering the first differential function equal to zero, the condition for maximum horse-power is obtained. From this it is found $h = H \div 3$, that is, the maximum horse-power is obtained when the discharge is regulated so that the head causing discharge or absorbed in overcoming friction is one-third the static head.

The computations on which the diagram is based were made by assuming given diameters of pipe and lengths of 1,000 feet, with coefficients obtained from Kutter's formula. Taking the above condition for maximum horse-power, $h = H \div 3$, and substituting this value of h in the equation from which it was derived, the horse-power $= K\sqrt{H^3}$, where K is a constant. This shows that the maximum horse-power varies as the head raised to the $^3/_2$ power, when the diameter and length of pipe remain constant.

The curves platted with lightly dotted lines show the quantity of water used; for example, given a 60-foot head and an 18-inch pipe to find the discharge. A horizontal line drawn through the 60-foot head intersects the 18-inch pipe curve very close to the 15-cubic-foot-per-second line, so the quantity of discharge for these conditions is, from the diagram, a little more than 15 cubic feet per second. The curves for the different size pipes are in the form, $x = k\sqrt{y^3}$. To illustrate the use of the diagram for obtaining the size of the pipe to be used to produce maximum horse-power with a given head and length of pipe, assume 114 feet as the available head, 45 cubic feet per second as the maximum flow and 1,600 feet as the length of pipe. A horizontal line through the 114-foot-head line intersects the 24-inch-pipe line at about 44 cubic feet, and the given head with a length of 1,000 feet of pipe of that size under these conditions will, according to the diagram, produce 380 horse-power. Since the velocity and hence the maximum horse-power, varies inversely as the square root of the length of the pipe when the head of water and the diameter of pipe are constant, for a 1,600-foot pipe the horse-power would be $380 \div \sqrt{1.6} = 302$ horse-power. From the diagram the velocity of discharge will be about 14 feet per second for the same conditions.

The computations were made and the curves of the diagram were platted as thesis work by Mr. W. P. Tams, under the direction of Pro. L. S. Randolph, professor of mechanical engineering in the Virginia Polytechnic Institute.—*Engineering Record.*

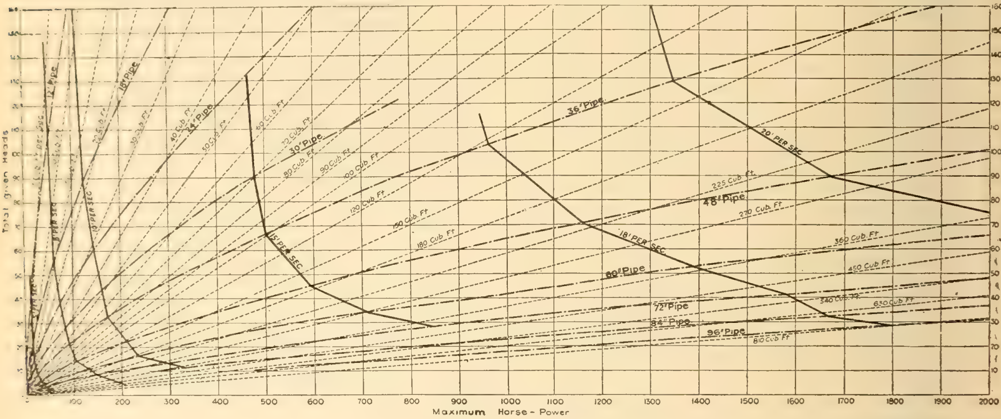


DIAGRAM OF THE MAXIMUM HORSE-POWER OBTAINABLE FROM WATER UNDER DIFFERENT HEADS IN PIPES OF DIFFERENT SIZES.

A. I. E. E. ANNUAL.

The annual meeting of the American Institute of Electrical Engineers will be held at Asheville, North Carolina, June 19 and 20, 1905.

NATIONAL ELECTRIC LIGHT CONVENTION

The annual convention of the National Electric Light Association will be held at Denver and Colorado Springs during the week commencing June 5. Elaborate arrangements are being made and a splendid meeting is expected.

A catalogue recently received from the Wellsman-Seager-Morgan Company, Cleveland, Ohio, tells of their facilities to build and install high grade water power equipment. They are prepared to install the Jolly-McCormick turbine.

PUBLICATIONS.

A bulletin recently received from the Automatic Electric Company, Chicago, gives a technical description of the Strowger automatic telephone system, the author being F. Lubberger.

A large line of electrical specialties, including switches, fuse box, flush receptacles, panel boards, etc., are illustrated and described in the January catalogue of the Trumbull Electrical Manufacturing Company, of Plainville, Conn.

Messrs. Longmans, Green & Company, 39 Paternoster Row, London, Eng., have issued the ninth edition of ''Telegraphy,'' by Sir W. H. Preece, K.C.B., F.R.S. The book has been thoroughly revised and greatly enlarged, and includes descriptions of the most modern devices used in telegraphy.

F. M. F. Cazin has issued a second edition of his book, ''What Next in Electric-Lamp Making,'' which contains illustrations and a description of the Cazin lamps, of which he is the inventor. The frontispiece is an illustration of a 50 candle power Cazin lamp first used at Amsterdam, N.Y., on June 23, 1904, photographed after alternate run of 600 hours with an unabated efficiency.

Rickards' Corliss steam engines are described in a late catalogue published by the Corliss Engine Works, 4041 North Fifth street, Philadelphia. More than fifty years have passed since George H. Corliss built the first Corliss steam engine, which is considered one of the best types of the class of engine known as ''automatic cut off.'' Of the many styles of Corliss steam engines manufactured to-day, the ''Rickards'' ranks among the best.

''The Westinghouse Companies in the Railway and Industrial Fields'' is the title of an attractive booklet descriptive of the many Westinghouse industries, including those of the Westinghouse Electric & Manufacturing Company, Westinghouse Air Brake Company, Cooper Hewitt Electric Company, Sawyer-Man Electric Company, Pittsburg Meter Company, Canadian Westinghouse Company, and others. The views of the different works convey a splendid idea of the magnitude of the allied industries.

The Chase-Shawmut Company, manufacturers of electrical specialties, Newburyport, Mass., have just issued Bulletin No. 30, covering Boston cable clips and Shawmut marlin hangers. The Boston clip is the original metal cable clip which has been manufactured by them for a number of years, and is believed to be the best form of metal clip on the market to-day. The Shawmut marlin cable hanger is a new departure with them, but we understand that it has been very favorably received by the trade. It is cheaper than the metal form.

Section No. 3 of the Canadian General Electric Company's Supply Catalogue is devoted to construction material, and will be found of interest by all users of such. First appear illustrations and descriptions of glass insulators, followed by feeder wire insulators, strain insulators, glass floor insulators, toppins and sideblocks, porcelain cleats and knobs, iron brackets, conduit boxes and fittings, flexible tubing, galvanized iron guy wire, rope and trolley cord, construction tools and many other lines manufactured by the company.

A description of the Monarch Engine Stop and Speed Limit System is found in a new catalogue recently sent us by the Consolidated Engine Stop Company, 100 Broadway, New York. This system is a mechanical device, operated by electricity, that can be applied to any engine without regard to make, size or speed. It supplements the governor and automatically shuts down the engine at any predetermined over-speed of the fly wheel. It shuts off the steam if a cylinder head blows out and stops the engine by means of tell-tales on rope drives when the rope strands.

The May Century, of New York, contains a review of the arc light by Charles F. Brush, the first of a series of papers on ''Great Inventions'' described by their inventors. Mr. Brush gives the history of arc and incandescent lighting, his own early experience and experiments, the beginning of public lighting by electricity and the rapid growth of the industry. There will appear in early numbers of the ''Century'' articles on ''Electric Traction,'' by Frank J. Sprague; ''The Transmission of Power,'' by Nikola Tesla, and ''The Air Brake,'' by George Westinghouse.

The fourth edition of ''American Telephone Practice,'' by Kempster B. Miller, has been issued by the McGraw Publishing Company, New York, and we predict for it a very favorable reception, as we doubt if we have ever seen a more complete work. The third edition contained 530 pages and 379 illustrations, while the fourth edition contains 904 pages and 643 illustrations. The author has presented in a clear manner the general principles of telephony, the design and construction of commercial apparatus, the circuits connecting each apparatus into operative systems, and the methods used in the construction, operation and maintenance of these systems. Price, prepaid, $4.

Allis-Chalmers-Bullock, Limited, Montreal, manufacture two and three phase induction motors for alternating current circuits of any standard frequency, and publication No. 5, which reached us last month, is devoted to an exposition of the construction and uses of the ''Squirrel Cage'' Type AN motor. This type is especially adapted for turbine pumps, a good example of their utility in this respect being afforded by the waterworks plant installed at the town of Lethbridge, Alberta, by this company. It consists of two vertical 150 h.p. induction motors of 1,200 r.p.m., directly connected by 14-foot shafts to Worthington vertical turbine pumps for domestic purposes, and two horizontal 50 h.p. induction motors similarly connected to horizontal turbine pumps for fire purposes.

Bulletin No. 836, issued by the Canadian General Electric Company, Toronto, is descriptive of their single phase Thomson Type ''I'' induction meter for house service, which is claimed not only to retain the desirable features of previous forms, but also to have many improvements in the simplicity and arrangement of the parts, together with a more pleasing appearance and a material reduction in both size and weight. Circuits of widely different characteristics can be accurately metered with this device, these results having been obtained by the introduction of several new and valuable features, one of which is that the torque or turning moment is extremely high.

PRICES FOR STREET LIGHTING.

The city of New York has just signed contracts for its street lighting. The following are the rates to be paid the different companies, and are the result of competitive bidding:

GAS LIGHTING.

Weschester Lighting Company, open-flame lamp	$ 23.70
Queens Borough Gas and Electric Company, open-flame lamp	25.00
Queens Borough Gas and Electric Company, per thousand feet, city use	1.46
East River Gas Company (Queens), open-flame	19.63
Brooklyn Borough Gas Company, open-flame	19.00
Wellsbach street lighting (Brooklyn), Wellsbach	29.70
Wellsbach street lighting (Queens), Wellsbach	29.70
Newton and Flushing Gas Company, open-flame	24.70
Brooklyn Union Gas Company, open-flame	15.70
Brooklyn Union Gas Company, Wellsbach	30.75
Woodhaven Gas Light Company, Wellsbach	30.75
Woodhaven Gas Light Company, open-flame	21.75
Central Union Gas Company (Bronx), open-flame	21.90
Richmond Hill and Queens Company, open-flame	21.75
Richmond Hill and Queens Company, Wellsbach	30.75
New York and Richmond, open-flame	21.00
Standard Gas Light Company, open-flame	12.80
Northern Union Gas Company, open-flame	23.55
Newton Gas Company, open-flame	24.75
New Amsterdam Gas Company, open-flame	12.00

ELECTRIC LIGHTING.

United Elecric Light & Power Company, 2,000 candle power	$146.00
New York Edison & Manhattan, 2,000 candle power	146.00
New York and Queens Light and Power, 2,000 candle power	$124.10 to 131.00
Bronx Gas & Electric, of Westchester, 2,000 candle power	146.00
Westchester Lighting Power, 2,000 candle power	146.00
Brush Electric & Illuminating Company, 2,000 candle power	146.00
Edison Illuminating Company, (Brooklyn,) 1,200 candle power	124.00
Flatbush Gas Company, 1,200 candle power	116.00

Mr. K. L. Aitken, consulting engineer, Toronto, is laying out the power equipment for the new Brampton factory of the Copeland Chatterson Company, Toronto.

MOONLIGHT SCHEDULE FOR JUNE.

Date.	Light.	Date.	Extinguish.	No. of Hours.
June 1	8 00	June 2	3 30	7 30
2	8 00	3	3 30	7 30
3	8 00	4	3 30	7 30
4	8 00	5	3 30	7 30
5	8 00	6	3 30	7 30
6	8 00	7	3 30	7 30
7	8 00	8	3 30	7 30
8	10 00	9	3 30	5 30
9	10 45	10	3 30	4 45
10	11 20	11	3 30	4 10
12	0 00	12	3 30	3 30
13	0 30	13	3 30	3 00
14	1 10	14	3 30	2 20
15	No Light	15	No Light	
16	" "	16	" "	
17	" "	17	" "	
18	8 10	18	10 20	2 10
19	8 10	19	11 00	2 50
20	8 10	20	11 45	3 35
21	8 10	22	0 20	4 10
22	8 10	23	0 50	4 40
23	8 10	24	1 20	5 10
24	8 10	25	1 50	5 40
25	8 10	26	2 20	6 10
26	8 10	27	2 50	6 40
27	8 10	28	3 20	7 10
28	8 10	29	3 30	7 20
29	8 10	30	3 30	7 20
30	8 10	July 1	3 30	7 20

Total.............146 00

RELIEVING CONGESTED TRAFFIC AT RUSH HOURS.*

By D. McDonald.

All that has been said or written in regard to other difficult problems of a like nature, such as congestion of traffic in London, the difficulties of getting quickly through the centre of Paris on a gala day, the irritating slowness of a horse or cable car ride through Broadway, up to recent date, the tedious features of all the best plans or remedies that have been already tried to prevent overcrowding in all public places or vehicles; all this verbal and written information would be a fitting preamble to convey to the ordinary reader a faint idea of the difficulty of the problem that we are endeavoring to solve.

We are requested to deal with a question that is difficult of solution, and to enter immediately into the practical discussion of this question we must cite certain figures concerning the growth of street railway business that tend to show how quickly the existing rush hour conditions have been thrust upon us and the practical catering that street railway companies all over this continent have furnished in the last ten years, to meet the requirements of traffic.

Statistics prove that from 1892 to 1903 the mileage of street railways on this continent has increased from about 8,000 to 25,000 miles, which means practically, on account of transforming electric, that since 1890, which was about the birth year of electric traction on a large scale, 25,000 miles of track were laid at a cost of $2,150,000,000, and that said street railway companies are now carrying an average of 5,000,000,000 passengers per annum. Why should it not be overcrowded?

These ten cipher figures to which the world has been unaccustomed in the way of increased traffic lead us to believe that street railway companies have not spared their efforts to cater to public comfort, especially when we stop to consider that this phenomenal work has been done by 850 companies and that perhaps less than 100 companies of this number have to deal with the overcrowding problem which we are now discussing.

If we take the existing conditions in towns of three or four hundred thousand inhabitants, we find that the working population may be one-half that number, and again that a quarter of said number (100,000 people) usually work in the business or down-town section of the city, which section is generally limited to a square of about one mile in length and a quarter or a third of a mile in width. Seventy-five thousand persons of this 100,000 would like to get home quickly and all want to board cars in ten or fifteen minutes at six o'clock. The question naturally arises how many cars with a capacity of fifty to sixty (seated or standing) will be required to carry this rush conveniently. Seventy-five thousand divided by fifty equals thirteen hundred cars.

The answer seems easy, and if companies could afford (in our day of cheap fares and transfers) to furnish that number of cars, to be used for fifteen or twenty minutes per day, this remedy would seem excellent.

It must not be forgotten that these thirteen hundred cars are only the rolling stock necessary to provide the desired accommodation for down-town passengers, and that at the same hour the rest of the system must be provided for, which might possibly mean one hundred or two hundred cars more, to provide the same roomy service, but as already stated the settling of the question would be easy, though impracticable financially for the company, if we did not have to contend with a still greater difficulty, which is "Time."

This "Time" difficulty comes from the natural desire of everybody to rush home at the same hour, which is easier to imagine than to cure. Hence the thirteen hundred cars above referred to must be rushed through the business centre of the city in ten or fifteen minutes, and this is where the plan becomes impossible.

Said business centre of city is generally provided with two streets at most where this traffic must be taken on, that is to say, two lines going east and two lines going west or north or south, as the case may be.

The closest headway that may be run by cars, at five or six miles an hour speed, is about 20 seconds; hence we must find a means of running 1,300 cars over four tracks in 15 minutes or 900 seconds; that is to say, we must run 325 cars over each track in 900 seconds, which means that the interval between cars must be less than three seconds. This is a material impossibility, and if each car must have a headway of 20 seconds we arrive at a total time space of (325 × 20 equals 6,500 seconds, equals 108 minutes) or 1 hour and 40 minutes to let the procession go by.

It is evident from the above figures that the possibility of relieving congestion with an unlimited number of cars, even if it were approved as a commercial venture, cannot be done without sacrificing time and speed, which would probably aggregate a larger general loss than that above mentioned and also give rise to greater recrimination than the disagreeable quicker ride that passengers must endure under present conditions.

There is a maximum in all measurements and the limit of cars that a city street may accommodate is pretty nearly covered by the service that most companies are at present giving in the heart of busy cities.

The European plan of numbering and limiting passengers, which, by the way, is generally disregarded in most European countries in Sunday and holiday rushes (for they do business calmly and amuse themselves rapidly), would not suit our speedier temperament.

It would not avail us much to get a roomy seat in a blockade, and most of our country men would prefer to get there standing.

The no-seat no-fare plan would certainly cause an irresistible desire with most people to prefer standing room.

The limiting of the number of passengers would be a good move in favor of the companies, as it would reduce the actual loss caused by missing fares, but it yet remains to be seen what public favor such a limitation would meet with in this busy country. The first passenger to be refused admittance in such a case takes it very bitterly, and if he happens to be accompanied and there is only room for one he is forced to give way to another passenger who should have waited. Again, if a car is filled at this corner a would-be passenger must wait, whilst another patron a block further on, who arrived later, on account of somebody getting off, will be served first. All these little intricacies which appear trivial when not in force are exceedingly aggravating in practice, and to Canadians or Americans, who are constitutionally in a hurry, become intolerable. Consequently we are forced to the following conclusions:

---

* Paper read before the Canadian Street Railway Association.

1. That congestion at rush hours cannot be avoided.

2. That it may be possible to relieve the crush by the addition of a reasonable number of cars to a limit where speed must not be sacrificed.

3. That with a view to further increasing the maximum number of cars that may be run without loss of time, most cities should consider the advisability of increasing the speed and giving clearer right of way to allow space for more cars and thereby afford greater and better accommodation to the public.

4. We are inclined to think that when the London business man, whether riding in a hansom or seated on the wet or dry top of an omnibus, will be able to ride directly to his office in the business centre, without having to worry about the blockade that he is treated to daily; when the Parisian count or citizen may be able to drive from the opera to the Louvre on a busy afternoon, a distance of a quarter of a mile, without going ten blocks out of his way; when the devout church goer or the impassioned theatre patron can attend service or play without having to share in the final disagreeable crush which is an integral part of all such meetings; when the camel will go easily through the eye of the needle without ruffling its silken sides; when a large city and maddening throng will cease to be synonymous, then may it be that the "no-seat, no-fare missionary," the "car passenger rights' association crusaders" and a small percentage of street car patrons who live eternally in the winter of discontent, may realize their very improbable dreams, and then we may all rejoice that the rush hour crush and congestion will have totally disappeared.

THE DOBLE WATER WHEEL.

The Abner Doble Company, of San Francisco, announce that arrangements have been made with the John McDougall Caledonian Iron Works Company, Limited, of Montreal, Canada, whereby the latter become sole licensees for the manufacture of the Doble system of water wheels in the Dominion of Canada. The tangential water wheels and needle regulating nozzles manufactured by the Abner Doble Company are well known for their excellence of design and workmanship, and considerable engineering interest has recently been shown in relation to the four 8,000 horse power wheels which that company has built for operation in California power plants. The McDougall Company have one of the most extensive machine shops in Canada, their plant including machine shops, pattern shop, foundry, forging works and structural material shop. Their plant is therefore well equipped for the manufacture of water wheels and other hydraulic machinery. They already have in hand the building of a 100 horse power wheel to operate under 170 ft. head taking water through a 3½ in. jet and having a speed of 130 revolutions per minute. The Canadian licensees are prepared to furnish the steel pipe, structural work and all machinery necessary for complete power plants, and the Doble Company requests that all engineers or parties interested in water power developments in Canada, address the McDougall Company direct. They have retained the Abner Doble Company as their consulting engineers.

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SPARKS.

The Golden Light, Power & Water Company, Golden, B.C., has been incorporated.

The corporation of Nelson, B.C., have sold $150,000 of electric light debentures, the proceeds to be applied to establishing a municipally owned electric light and power plant.

The employees of the Ottawa Street Railway Company have been given an increase in wages. Men over two years in the service will get $1.75 instead of $1.65 on week days, and $1.95 instead of $1.85 on Sundays, for a ten-hour day.

The promoters of the Lake Erie and Port Dover Radial Railway Company are reviving their scheme for building an electric railway from Brantford to Port Dover, Ont. Messrs. E. L. Goold and Thomas Elliott are behind the company.

Mr. Baxter, of Windsor, Ont., has submitted to the City Council of Guelph a detailed report on the cost of extending the gas plant. Ald. Cunningham favored the extension of the electric light plant at the same time, but the majority of the Council are in favor of deferring this step until next year.

The city of Edmonton, N.W.T., is asking for tenders up to May 15th for supply of transformers, switchboard, wire and other material necessary in the installation of series arc lighting. Particulars may be obtained from Mr. J. H. Hargreaves, Public Works Commissioner.

The Otonabee Power Company, Peterboro, Ont., have decided to discontinue the meter system and to adopt the flat rate basis exclusively. Eight lamps will be furnished at a cost of $12 per year, with a charge of $1 for each additional lamp. The company are now supplying light to over 600 houses.

Mr. E. B. Wingate, of Hamilton, is making the final survey for the radial electric railway from Hamilton to Guelph, Ont. Hon. Charles D. Haines, the promoter, states that Senator Kennedy has joined him in the Guelph project, and has agreed that both the Guelph and Brantford roads should be built simultaneously.

The Toronto and Hamilton Railway Company invited tenders up to April 27th for the construction of their road between Toronto and Niagara Falls, Ont., but as the time was found to be too short for intending contractors to make the necessary estimates, it has been decided to extend the date for one month. Mr. Frederic Nicholls is president of this company.

A meeting of the Chaudiere power interests will be held in Ottawa very shortly to consider the carrying out of the suggestions of the experts, Messrs. William and John Kennedy, of Montreal, respecting the construction of a dam above the Chaudiere to conserve the power now going to waste and to obviate the anchor ice difficulty.

The Emerson Roseau Power Company, Emerson, Man., have elected the following officers: President, John Stewart, Winnipeg; vice-president, Hon. D. H. McFadden; secretary, A. H. Logan; treasurer, A. E. Hoskins; manager, George Pocock. The capital stock has been placed at $200,000. The company purpose developing and transmitting power for Emerson, Ridgeville and surrounding places.

The City Council of Montreal, after sending an expert to examine several American plants, have decided to adopt steam pumps for waterworks purposes. Mr. W. McLea Walbank, vice-president of the Montreal Light, Heat & Power Company, claimed that electric pumping was cheaper than steam by a considerable margin, but as the electric pumps previously installed by the city had been the result of some law suits, the majority of the Council were in favor of steam. Mr. Walbank claims that the cost of pumping 1,000,000 gallons of water by steam is $8.88, and by electricity $6, a saving of $2.88 in favor of the latter. The first cost is also largely in favor of electricity.

PERSONAL

Mr. J. C. Choirnet has taken charge of the electric light plant at Parrsboro, N.S.

Mr. E. A. Chisholm, of Montreal, has been appointed electrical superintendent of the St. Johns Electric Light & Power Company.

Mr. Marshall, formerly city electrician of Kamloops, B. C., has recently accepted a position with the Canada Foundry Department of the Canadian General Electric Company at Vancouver.

Mr. A. M. Grantham, C. E., who has for some time been employed in the drafting room of the Toronto Railway Company, has been appointed purchasing agent, to succeed Mr. Ewen Mackenzie.

Mr. T. F. Kenny has been appointed Mechanical Engineer of Allis-Chalmers-Bullock, Limited. He graduated from the Department of Mechanical Engineering at McGill University in 1896 and then spent two years with the British Columbia Iron Works. For the past six years he was Mechanical Engineer for the Jenckes Machine Company, Sherbrooke, Que.

Mr. K. L. Aitken, consulting engineer, Toronto, has prepared specifications covering the two 1,000 horse-power induction motors and other electrical apparatus for the new high pressure fire pumping system for the City of Toronto.

The Northwest Electric Company, Limited, have opened up establishments in Calgary and Edmonton, N. W. T. They are doing a general supply business and are already installing several isolated plants in the surrounding districts. Mr. C. Cunningham is the manager, and E. A. Thompson secretary-treasurer.

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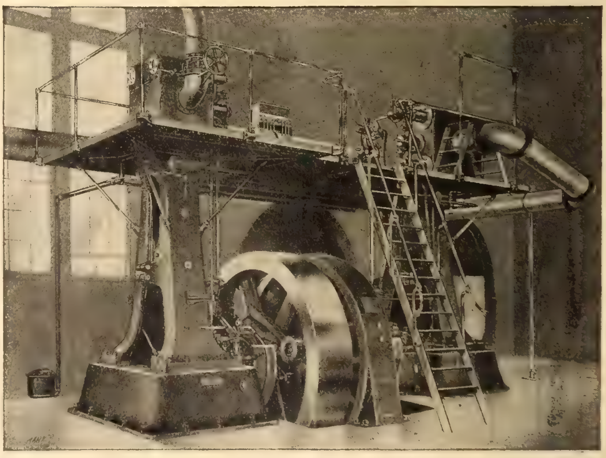

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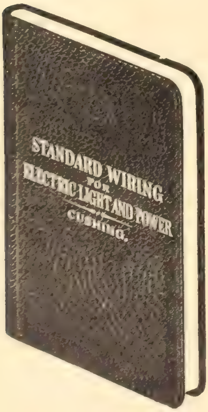

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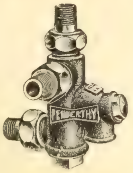

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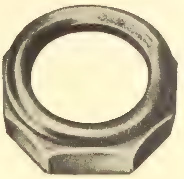

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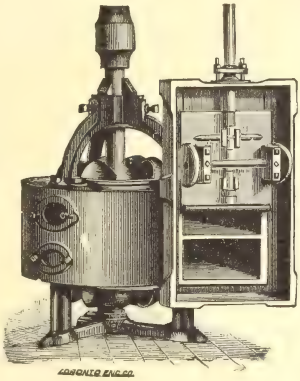
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TRADE NOTES.

D. K. McLaren, manufacturer leather belting, Montreal, has made arrangements with the Threshers' Supply Company, of Winnipeg, to represent him in Manitoba and the Territories.

The Robb Engineering Company have received an order from the City of Calgary, N.W.T., for a 350 horse power cross compound Corliss engine for use in the city's electric lighting plant.

A new company has been incorporated, under the name of the Laurie Engine Company, Limited, to acquire the business of the Laurie Engine Company, of Montreal. The capital stock is placed at $250,000.

Allis-Chalmers-Bullock, Limited, have removed to more commodious offices in the Sovereign Bank Building, 232 St. James street, Montreal, where they will be pleased to meet their customers and friends.

The Canadian Westinghouse Company have removed their Montreal office to the new Sovereign Bank Building, 232 St. James street, where they will have greater accommodation for their increasing business.

The Robb Engineering Company, Amherst, N.S., have recently moved into their new machine shop. It is a magnificent structure, being more than half glass, and is equipped with motors for driving the various machines.

The town of Glace Bay, N.S., has ordered from the Robb Engineering Company, of Amherst, N.S., a 375 horse power Corliss engine and a 150 horse power Robb-Mumford boiler for the extension of their electric lighting plant.

The St. Lawrence Engine Company, Limited, has been incorporated under an Ontario charter, with head office at Brockville and a capital stock of $40,000. It is proposed to manufacture engines, boilers, etc. The promoters include Messrs. W. H. Comstock and H. W. Going.

The Hill Electric Switch Co., of Montreal, have moved recently from St. Paul street, owing to the fact that their factory was too small. They have taken a large factory on St. Lawrence Main, and intend doing a much larger business.

Bulletin No. 31 just issued by the Chase-Shawmut Co., Newburyport, Mass., refers to Shawmut conduit outlet bushings and lock nuts. This material is said to be meeting with much favor on account of its uniformity and neatness of appearance.

Among recent contracts awarded to Allis-Chalmers-Bullock, Limited, Montreal, were three 450 h.p. induction motors, one 100 h.p. induction motor, rope driven, for use in the Royal and Glenora Mills of the Ogilvie Milling Company; six type E-24 Ingersoll-Sergeant rock drills for the B.C. Copper Company; two Ingersoll-Sergeant sub-marine drills for the Montreal Harbor Commissioners; one Gates K crusher with engine and other equipment to Michael Connolly for his contract at St. Raymond, Que.

The Stratford Mill Building Co., Limited, Stratford, Ontario, the well-known mill contractors of that thriving city, report that they are exceedingly busy at the present time, having a large number of mill contracts both for Ontario and for the West, while the prospects for the future were never so bright. They also advise that the engine and boiler department are working at high pressure to take care of their orders. The Brown engine as manufactured from their drawings has grown very rapidly in public estimation, and has made friends wherever it has gone. It has been unexcelled, and is an especial favorite for electric light equipment owing to its reliability and the absence of the many annoyances that are sometimes to be found in the construction of an engine of more complicated design. They claim to be in a position to furnish plants for all purposes second to none in Canada, and should be pleased to promptly furnish any known desire.

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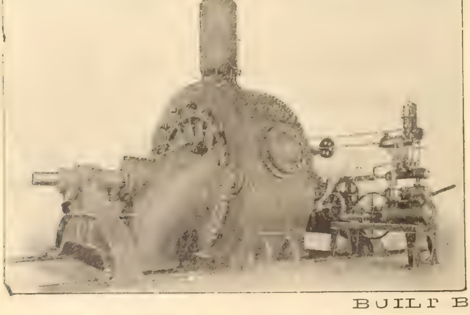

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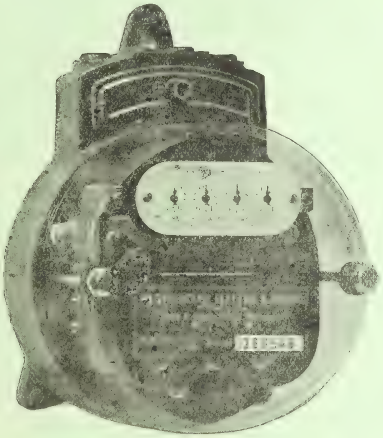

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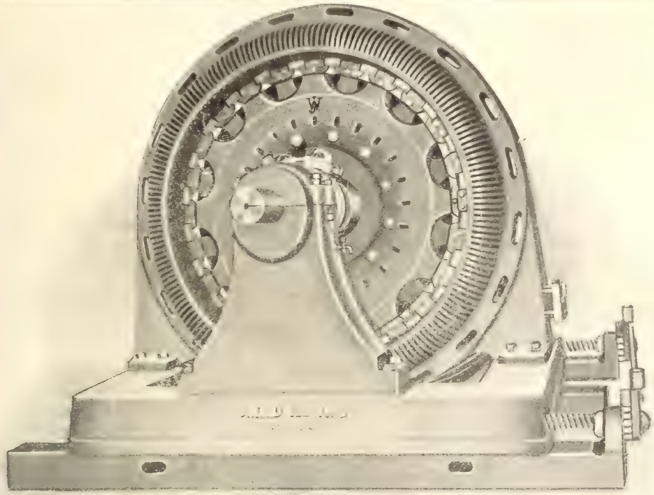

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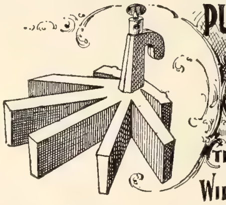

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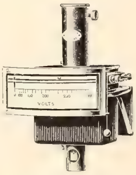

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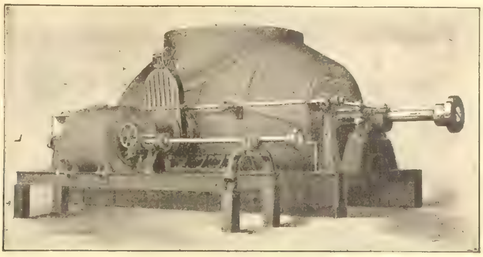

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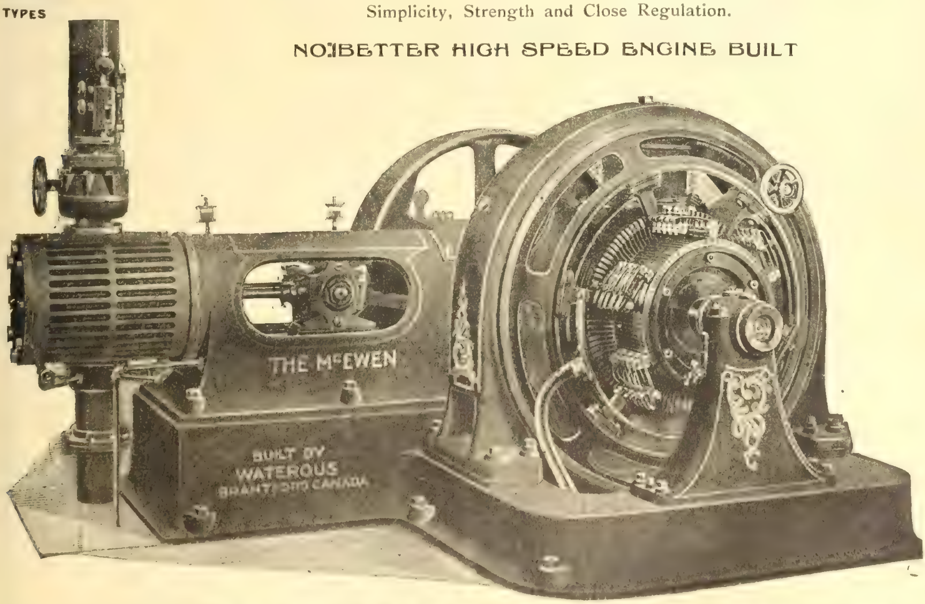

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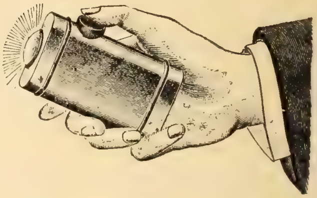

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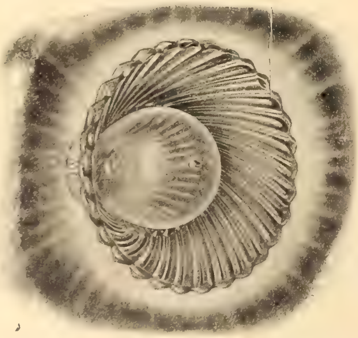

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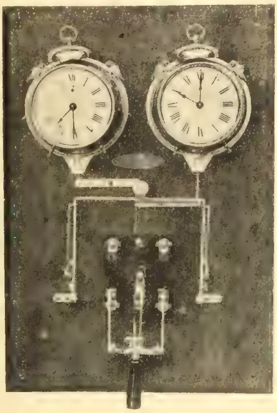
THE B. & W. TIME SWITCH.

A reliable time switch at a moderate price has been put upon the market by the Berlin Electric Company, Berlin, Ont. The company manufacture two types of switches mounted on slate or oak panels in sizes ranging from 25 to 75 amperes. The illustration shows a Type B switch mounted on an oak panel. As will be seen, it consists of two time movements, one for turning "on" and the other for turning "off" the lights at some predetermined time. The Type A has only one time movement and turns "off" the current only at the hour set on the clock dial.



The mechanism is very simple and of substantial construction. The clock is mounted on an aluminum casting which fits the back snugly, making it dust proof. For winding and setting the clock the case can be easily removed by turning aside two small catches at the top of the clock. The electric switch is of the standard knife type and is operated by a spring; when the switch is open or closed it is held in position by a small lever having a catch which is released by the alarm movement of the clock when the appointed time arrives, and the switch is then opened or closed as the case may be. The switch can, however, be operated independently at any time regardless of the automatic features.

The apparatus, besides being simple and absolutely reliable, is of very neat design and can be sold at a moderate price. Patents have been obtained in both Canada and the United States.

The tender of Mitchell Porter and William O'Donnell, of Chatham, N. B., has been accepted for operating the street lighting plant at Fredericton, N. B., their price being $1,600 per year. Mr. W. H. McGinn, late superintendent of the electric plant, will test public opinion on the action of the Council by offering himself as a candidate for aldermanic honors.

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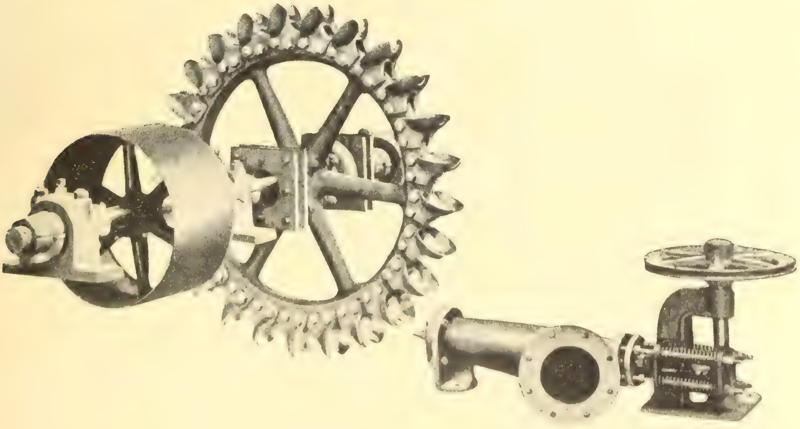

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The Canadian Meter Company, formerly of Windsor, Ont., are building a new factory in Hamilton.

It is understood that the Raymond Gas & Engine Company have decided to locate at Port Arthur, Ont.

A separate power house is to be built in connection with the Agricultural buildings in Winnipeg, for which tenders will be received up to the 17th inst.

J. D. McRae has made a contract with the village of Eganville, Ont., to supply seven electric lights of 50 c. p. each, all night service, for the sum of $16.50 per lamp per year.

Mr. E. G. Warren, manager of the Greenwood Electric Company, has secured the contract for wiring the new zinc concentrator at Roseberry, B. C., and for installing two 9 k. w. generators.

Leitch Bros. have installed an electric light plant at Oak Lake, Man.

At the sixth annual commencement of the Thomas S. Clarkson Memorial School of Technology Potsdam, N.Y., June 9, 1905, Mr. C. J. H. Woodbury, assistant engineer of the American Telegraph and Telephone Company, Boston, Mass., will deliver the address to the graduating class, on "The Engineer as an Economist."

The Chatham, Wallaceburg and Lake Erie Railway is building a new line of electric railway from Chatham to Wallaceburg, Ontario, a distance of about 20 miles, through a rich farming and fruit raising country. An order for four double equipments and one quadruple equipment of 101 railway motors has been placed with the Canadian Westinghouse Company, Limited.

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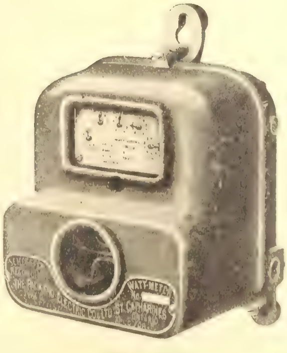

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Canadian Westinghouse Co.	III
Canadian General Electric Co.	I
Electric Repair and Contracting Co.	II
Packard Electric Co.	v
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Thompson & Co., Fred	IV
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WIRES AND CABLES

Canada Metal Co.	II
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Philips Electrical Works, Eugene F.	I
Wire & Cable Co.	

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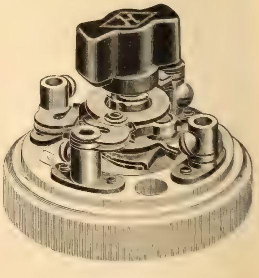


PUBLICATIONS.

The Smart-Turner Machine Company, of Hamilon, have issued Bulletin No. 5 referring to pumping machinery.

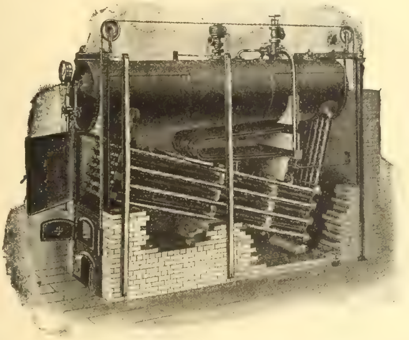
The Nernst Lamp Company, of Pittsburg, have issued a very neat booklet entitled "Bank and Office Lighting by Electricity".

The Penberthy Injector Company, of Windsor, Ont., advise us that they will gladly send their No. 21 catalogue to any one who may be interested in their line of manufactures.

The latest catalogues from the Canadian Westinghouse Company, Hamilton, Ont., are No. 1109, relating to the single phase railway system, and No. 1110, referring to the Westinghouse Catenery line construction.

We acknowledge the receipt of the Ninth Annual Report of the International Association of Municipal Electricians. This convention was held at St. Louis, Mo., September 13 and 14, 1904. The treasurer of the Association is Mr G. F. Macdonald, Ottawa, while Mr. John S. Craig, of Toronto, is a member of the executive committee.

To take care of its rapidly increasing business, the Hamilton Cataract Power, Light and Traction Company are making extensive additions to their power plant at DeCew Falls. Orders specifying prompt delivery have been placed with the Canadian Westinghouse Company for the following apparatus: Two 6400 k.w. 3-phase, 2400 volt, 8000 alteration, 287 r.p.m., 2 bearing generators with motor-driven exciters and switch-board apparatus; four 3200 k.w. oil insulated water cooled raising transformers.



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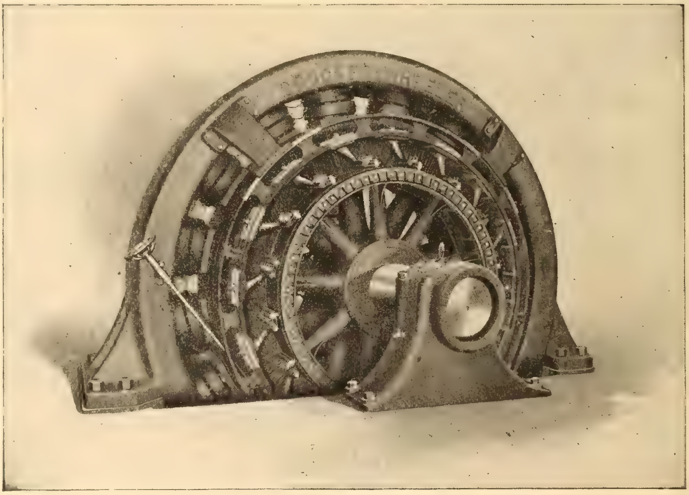
Apparatus



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ST. CATHARINES

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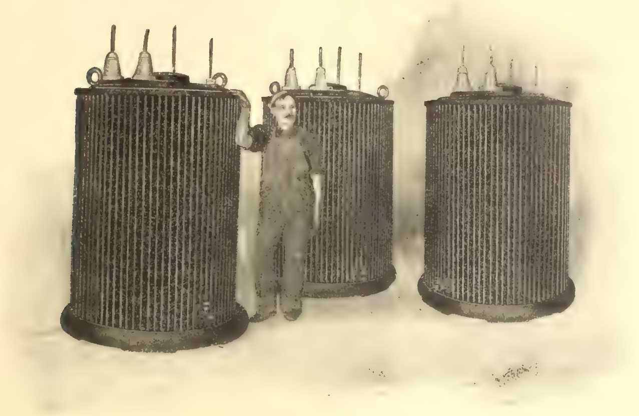

Pittsburgh Transformers.

We wish to put it into as plain words as possible that Pittsburgh transformers are the best transformers made, and that we give our customers the best and promptest service.

There is only one real way to show this, and that is for you to order a transformer and see for yourself. You run no risk whatever, for your order will be accepted by us with the distinct understanding that you can send the transformers back any time within sixty days, if you do not like them, and we will pay the freight both ways. It does not matter what your reasons may be ; your mere statement of the fact will be final.

We may as well own up that we don't run any risk either, for nobody has yet rejected our transformers, and that offer has been standing seven years. Will you not send us the order ?

Pittsburgh Transformer Company
Pittsburgh, Pa.

SPARKS.

The City of Valleyfield will build an electric light plant, and has retained the services of Mr. Charles Brandeis, consulting engineer, of Montreal, in connection with same. Work will be started immediately.

The Berlin Electric Company have secured the contract for the installation of the lighting and electrical machinery for the Clare Bros. & Company, Limited, Preston, Ont., who are changing their plant over to electric drive. The apparatus throughout will be Westinghouse.

The St. Lawrence Coal Company, Limited, which owns considerable excellent coal properties at North Sydney, Cape Breton, will shortly commence operations and install a plant with a capacity of raising 500 tons of coal a day. Mr. Charles Brandeis, C.E., of Montreal, has been retained as chief engineer of the company.

It is understood that the city of Winnipeg has been offered, for $85,000, an option on the Manitoba or Mud falls, situated on the Winnipeg river, about 65 miles from the city. The property is owned by Mr. A. R. Hemli and it is claimed that New York engineers have reported that 18,000 horse power can be developed and transmitted to Winnipeg at a cost of $1,000,000.

The new C.P.R. station at Revelstoke, B.C., will have its own electric lighting plant, which is being installed by the A. F. Barber Company, of Vancouver. The same company are also installing a private electric lighting system in the new C.P.R. hotel at Victoria. It is estimated that the plant will cost over $25,000 and will be one of the finest on the Pacific Coast.

Mr. R. S. Kelsch, consulting engineer, Montreal, appeared before the Railway Commission in Ottawa on May 25th, in the hearing of the City of Ottawa versus the Ottawa Street Railway Company re the Bank street subway. The City wishes to build a subway on Bank street, under the Canada Atlantic Railway tracks. The Street Railway Company claims that the construction of a subway would require additional feeders costing $10,000, and that it would be necessary to provide 336 horse power additional capacit in the power house. Mr. Kelsch, for the City, explained by means of curves how the power required to take a car through the subway a six miles per hour would be less than is required to start a car on the level and accelerate at the speed required to maintain schedule time on the Bank street lines.

MOONLIGHT SCHEDULE FOR JULY.

Date.	Light.	Date.	Extinguish.	No. of Hours.
July 1	8 10	July 2	3 30	7 20
2	8 10	3	3 30	7 20
3	8 10	4	3 30	7 20
4	8 10	5	3 40	7 30
5	8 10	6	3 40	7 30
6	8 10	7	3 40	7 30
7	8 10	8	3 40	7 30
8	10 00	9	3 40	5 40
9	10 30	10	3 40	5 10
10	11 10	11	3 40	4 30
11	11 50	12	3 40	3 50
13	0 30	13	3 50	3 20
14	1 20	14	3 50	2 30
15	No Light	15	No Light	
16	" "	16	" "	
17	" "	17	" "	
18	8 00	18	10 15	2 15
19	8 00	19	10 50	2 50
20	8 00	20	11 20	3 20
21	8 00	21	11 50	3 50
22	8 00	23	0 20	4 20
23	8 00	24	0 50	4 50
24	8 00	25	1 20	5 20
25	8 00	26	1 50	5 50
26	8 00	27	2 30	6 30
27	7 50	28	3 10	7 20
28	8 50	29	4 00	8 10
29	8 50	30	4 00	8 10
30	8 50	31	4 00	8 10
31	7 50	Aug. 1	4 00	8 10
			Total	156 05

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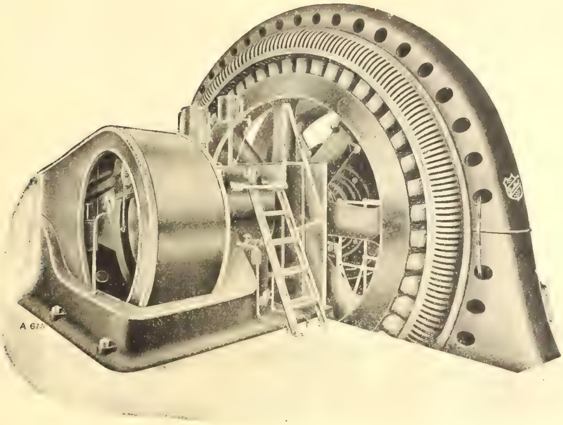

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SPARKS.

The Selkirk Electric Light & Power Company, of Selkirk, Man., has recently been incorporated by Messrs. James Stuart, Robert M. Stuart, H. Pollard, John T. Haig, of Winnipeg and [illegible] Stalker, of Selkirk. The capital is placed at $50,000.

The Windsor Hotel Company, Montreal, have decided to build an addition to their hotel. The new wing will contain 200 rooms, cafe, power house, etc., and be designed to leave no room for complaint as regards hotel accommodation in Montreal. Mr. W. S. Weldon, manager, says the power house for the new hotel will have a capacity in duplicate to operate all the lighting systems, electric motors, elevators, refrigeration systems, heating and ventilating. For both the present and new hotel, the services of Mr. R. S. Kelsch have been retained. He will have charge of all engineering work.

The Quebec Railway, Light & Power Company, Quebec, have retained the services of Mr. R. S. Kelsch, consulting engineer, Montreal, in connection with the reconstruction of their entire generation and distribution system. The increased demand for light and power supplied by this company necessitates the enlargement of their plant. The plans for reconstruction, when completed, will give additional capacity and a reserve capacity in all parts of the system, which will permit maintaining a reliable service under almost any emergency that may arise. The company will spend $300,000 on the improvements.

STEAM PLANTS

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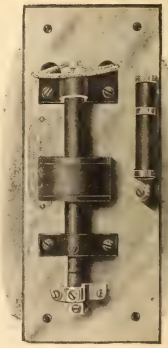
GARTON DANIELS LIGHTNING ARRESTERS

The Garton Daniels Lightning Arresters are devices made in many styles, for use on Electric Railway, Light and Power Circuits, both for Direct and Alternating Currents. They offer the discharge a path to earth of low resistance.

They also cut off the flow of normal current so that your circuits will not be grounded.

If you are interested we will mail you a pamphlet.



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SPARKS.

A by-law to raise $35,000 for an electric light plant will be voted on by the ratepayers of Napanee, Ont., on July 7th.

The Peterboro Radial Railway Company are said to be considering the extension of their line to Lakefield and Young's Point.

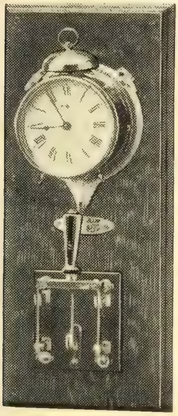
Associated with the municipal improvements at English Bay, Vancouver, B.C., will be the putting in of special electric lights along the pathways. An underground system of wires will be adopted.

The Portneuf & Quebec Electric Company of Quebec elected the following officers last month: President, C. F. Guay; vice-president, I. N. Belleau; secretary-treasurer, C. F. Delage, M.P.P.

The City Council of Vancouver, B.C., are considering the advisability of buying out the electric lighting and power plant at the close of the contract next year and running it under municipal ownership.

Mr. C. W. Bongard, dealer in electrical supplies, is removing from the building which he has occupied on Adelaide street West to larger premises at 130 Bay St., Toronto. This change has been rendered necessary by the growth of the business.

The town folk of Field, B.C., are now rejoicing in the recent decision of the C.P.R. to supply the town with electricity. The A. F. Barber Company, of Vancouver, secured the contract from the C.P.R. to erect poles and string the wires all over the town. The same company have also wired most of the buildings in Field.



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Gutmann Meters

As some of our competitors have circulated the report that an injunction had been obtained restraining the manufacturers of the Gutmann Meter from making these celebrated instruments here, we would say that such is not the case. We have a large stock on hand and a large shipment on the way from our Canadian Factory and can ship all orders immediately upon receipt.

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CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

Vol. XV. JUNE, 1905 No. 6.

PROGRAMME OF FIFTEENTH ANNUAL CONVENTION OF CANADIAN ELECTRICAL ASSOCIATION

Convention Headquarters, Canadian Society of Civil Engineers' Building, 877 Dorchester Street, Montreal.

WEDNESDAY, JUNE 21st.

10 A.M.—Meeting of Executive Committee.
10.30 A.M.—Opening Session.
Reports.
Papers: "Transformers," by R. T. McKeen; "Selection and Maintenance of Service Meters," by William Bradshaw; "Incandescent Lamps," by A. B. Lambe.
Question Box.

THURSDAY, JUNE 22nd.

10 A.M.—Papers: "The Operation of Alternators in Parallel," by A. L. Mudge; "Induction Motors," by H. A. Burson; "Heating of Enclosed Conductors," by Prof. R. B. Owens.
1.00 P.M.—Special Visit and Luncheon at the Allis-Chalmers-Bullock Company's Factory, Rockfield.
3.00 P.M.—Visits to Electrical Sub-stations, etc., in Montreal—Details to be furnished later.

FRIDAY, JUNE 23rd.

10 A.M.—Papers: "Economy of Isolated Plants," by K. L. Aitken; "Notes on Steam Engines and Boilers," by Wm. McKay.
Question Box.
2 P.M.—Election of Officers.
Unfinished Business.

LOCAL COMMITTEE.

H. D. Bayne, Chairman.

R. S. Kelsch.
F. Wilson Fairman.
R. E. T. Pringle.
C. F. Sise, jr
E. F. Sise.
Prof. R. B. Owens.
H. J. Fuller.
Wallace C. Johnson.
W. F. Dean.
Alf. Collyer.

TRANSPORTATION.

Persons attending this Convention should purchase a full fare one way ticket to Montreal, and get from the ticket agent from whom they buy, a certificate of purchase. This certificate when signed by the Secretary of the Association will entitle them to return at one-third fare over the G.T.R., C.P.R., or American roads.

Through the kindness of the Montreal Street Railway Company, special books of Complimentary Tickets will be furnished by the Secretary to all delegates attending the Convention in Montreal.

THE CANADIAN ELECTRICAL ASSOCIATION CONVENTION

The fifteenth annual convention of the Canadian Electrical Association will be held in the city of Montreal on Wednesday, Thursday and Friday, June 21st, 22nd and 23rd next. The programme, which is printed on the preceding page, is of an excellent character and should induce every central station, electric railway, telegraph and telephone man to attend.

Montreal is to the visitor one of the most interesting cities on this Continent. First incorporated in 1832, its population has grown to 350,000. It is the commercial metropolis of Canada, and being the head of ocean navigation is particularly lively during the summer months. Mount Royal, which is seven hundred feet in height and covers an area of four hundred and thirty acres, is the pride of the city. From various elevations splendid views may be had of the city and surrounding country.

Montreal possesses many fine churches and public buildings. Among the former are the parish church of Notre Dame opposite Place d'Armes, and St. James Cathedral, the latter commenced in 1852 and still unfinished. Chief among the educational buildings is the celebrated McGill University, the electrical and other laboratories of which will be open for the inspection of visitors to this convention. If space permitted, mention might be made of scores of other buildings and places of interest to the visitor, but a few words must be said about the convention programme.

Canadian Society of Civil Engineers' Building, 877 Dorchester Street, Montreal, where the Convention will be Held.

Through the courtesy of the Canadian Society of Civil Engineers, the business sessions will be held in the large meeting room of the Society's building at 877 Dorchester street. This building is close to the Windsor Hotel. Nine papers on a variety of subjects are promised, affording valuable information and plenty of material for useful discussion. The "Question Box," so much appreciated at the last convention, gives promise this year of being still more interesting and valuable. Mr. Dion, the editor, has been untiring in his efforts for its success. The well-known hospitality of the electrical men of the convention city is a guarantee that the visitors will not lack entertainment.

With the possible exception of Niagara Falls, it is doubtful if there is another place in Canada where there is so much to interest the electrical fraternity. Besides the several plants described in this number, there are many other interesting installations, of which we might mention the following :

The Lachine Canal power house, with two 75 k.w. a. c. three-phase 60 cycle generators for operating the lock gates and for lighting; the Dominion Cotton Company's mill at Maisonneuve, where alternating current to the extent of about 2,000 h.p. is used in motors throughout the works; the Locomotive & Machine Company's power plant, which includes two Western Electric generators, one engine-driven, the other motor-driven; the Canada Car Company, whose generating plant consists of two Curtis turbines direct-connected to two Canadian General Electric alternators; the Wire & Cable Company at 241 Guy street, where may be seen one of the most complete private plants in Canada and interesting applications of the individual drive, many machines starting and stopping automatically; the two stations of the Montreal Water & Power Company, the one located on Clarke avenue, Westmount, being operated by a Bullock three-phase induction motor of approximately 250 h.p., the other located on Charlevoix street, Point St. Charles, being operated by a synchronous motor; the new plant of the Bank of Montreal on St. James street, also a small though interesting installation at Ogilvie'e Royal Mill, consisting of a Dick-Kerr two-phase 220-volt generator formerly used to do the lighting of the mill but now operated as a motor. The motor generator sets at the Canadian Pacific and Great Northwestern Telegraph Company's exchanges are also of interest.

The Local Committee have made most complete arrangements, and given favorable weather, the success of the convention is assured. This committee is composed of Messrs. H. D. Bayne (Canadian Westinghouse Company), chairman ; R. E. T. Pringle ; Alfred Collyer (Allis-Chalmers-Bullock) ; C. F. Sise, jr., (assistant superintendent Bell Telephone Company) ; W. F. Dean (Canadian General Electric Company) ; R. S. Kelsch, consulting engineer ; H. J. Fuller (Canadian Fairbanks Company) ; Prof. R. B. Owens ; Wallace C. Johnson (Shawinigan Water & Power Company) ; E. F. Sise (Manager Wire & Cable Company) ; F. Wilson Fairman.

BOILER MAKERS IN TORONTO.

The seventeenth annual convention of the American Boiler Manufacturers' Association of the United States and Canada will be held at the King Edward Hotel, Toronto, on July 25, 26 and 27, 1905. Mr. J. J. Main, manager of the Canadian Heine Safety Boiler Company, is third vice-president of the association.

Mr. W. F. Dean.

Mr. H. D. Bayne, Chairman.

Mr. Alfred Collyer.

Mr. R. S. Kelsch.

Mr. Wallace Johnson.

Mr. E. F. Sise.

Mr. R. E. T. Pringle.

Mr. C. F. Sise, Jr.

Prof. R. B. Owens.

MEMBERS OF LOCAL COMMITTEE, CANADIAN ELECTRICAL ASSOCIATION CONVENTION,
MONTREAL, JUNE 21, 22 AND 23, 1905.

THE MONTREAL LIGHT, HEAT AND POWER COMPANY

By acquiring a majority of the capital stock of the Montreal Gas Company, Royal Electric Company, Montreal and St. Lawrence Light and Power Company, Imperial Electric Light Company, Standard Light and Power Company, Citizens' Light and Power Company, Temple Electric Company and Lachine Rapids Hydraulic and Land Company, the Montreal Light, Heat and Power Company control, with the exception of one small plant, the entire supply of gas and electrical energy in the city of Montreal and its suburbs. When, therefore, it is stated that Montreal consumes more electrically-transmitted water power than any other city in the world, and is the largest electrical centre in Canada, the magnitude of the company's system may be more clearly understood. This article will deal exclusively with the generation and supply of electric energy.

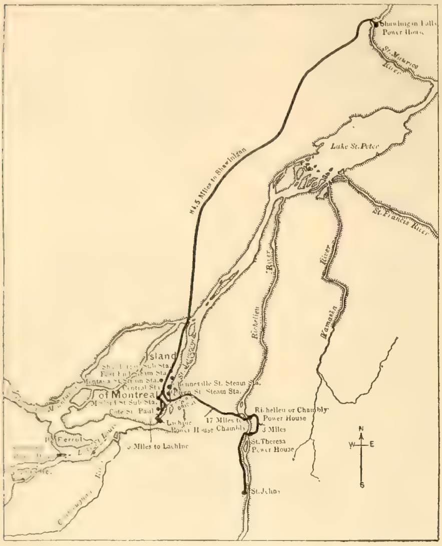


FIG. 1.—MAP SHOWING LOCATION OF WATER POWER PLANTS AND DISTRIBUTING STATIONS.

Power is derived from three sources, namely, Chambly, Lachine and Shawinigan, located at distances of 17, 5 and 85 miles respectively from the city. The capacity of the generators at these stations and the voltages used for transmission are as follows:

Chambly power house, 16,800 k.w.; 25,000 volts.

Lachine power house, 6,000 k.w.; 5,000 volts.

Shawinigan power house, 17,850 k.w.; 50,000 volts.

All the power generated at Chambly and Lachine is transmitted to Montreal, while perhaps 10,000 k.w. of the Shawinigan energy is thus utilized. A fifty-year contract requires the Shawinigan Water and Power Company to deliver up to 20,000 h.p. for electrical supply in Montreal.

There are also in various parts of the city reserve steam stations having a total capacity of about 6,000 k.w.

THE CHAMBLY DEVELOPMENT.

The power at Chambly is derived from the rapids of the Richelieu river and a head of about 32 feet is obtained by a dam extending across the river near the village of Richelieu. The power house is about 310 feet long by 50 feet wide, and the hydraulic equipment was designed for the development of 23,500 electrical h.p. There are eight main units, each consisting of four 51 inch McCormick turbines operating at 149 r.p.m. and direct connected to eight alternators. Four of these alternators were manufactured by the Canadian General Electric Company and are rated at 2,200 k.w. each, at 2,200 volts two-phase, while the other four are of the Stanley type and each has a capacity of 2,000 k.w. at 2,200 volts two-phase. All the machines are capable of a considerable overload for extended periods. They operate at 63 cycles, which is a compromise between 60 and 66 cycles, both of which frequencies were formerly found in the water power stations that contributed to electrical supply in Montreal. There are, in addition to these generators, two 300 k.w. 125 volt exciters, each direct connected to the horizontal shaft of two 27-inch turbine wheels rated at 450 h.p. and operating at 250 r.p.m. Lombard governors are employed for regulating the wheels. A certain amount of power is supplied at 2,200 volts to the neighboring villages of Richelieu, Chambly and St. Johns, but by far the larger portion is raised to a higher voltage for long distance transmission.

From each of the eight 2,200 k.w. two-phase generators, single conductor 750,000 c.m. paper insulated lead covered cables carry the current to the oil switches, which are manually operated and which can be connected to either of two sets of busbars. To the generator busbars are connected, through G.E. type "H" motor-operated oil switches, five banks of Westinghouse air-blast step-up transformers, each bank having a capacity of 5,500 k.w. By means of these

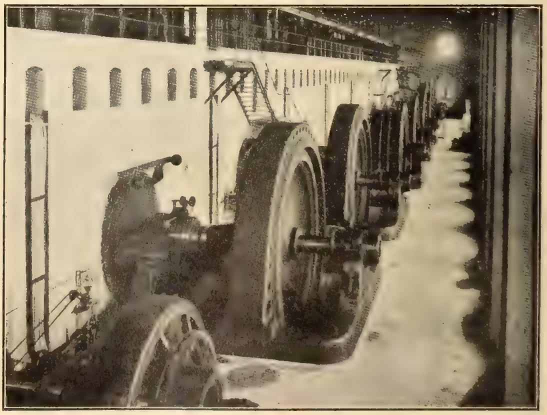


FIG. 2.—INTERIOR VIEW OF CHAMBLY POWER HOUSE.

step-up transformers, which are connected in "T" on the primary side, the voltage is transformed from 2,200 volts two-phase to 25,000 volts three-phase. The high tension current is then taken to a selector knife switchboard and from thence by means of three conductor 25,000 volt paper insulated cables to the overhead lines, the cables joining same in a terminal house.

After leaving the terminal house, the twelve bare conductors that make up the four three-phase circuits are carried on two separate pole lines, two circuits to a pole line. A short distance from the Chambly power house the two pole lines cross the Richelieu river. In this crossing, six spans are employed and six concrete piers erected in the river to support the poles, two poles being set in each pier. Each pole crossing the river is double cross-armed. The length of each span is about 125 feet.

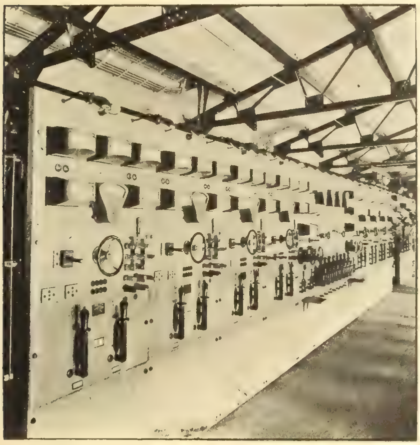


Fig. 3.—Generator Switchboard, Chambly Power House.

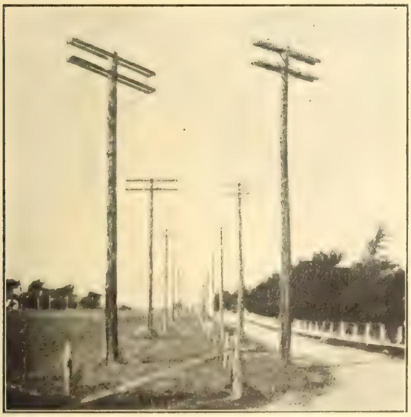


Fig. 4. Chambly Transmission Line.

A little further on from the river crossing, the Chambly Canal has to be negotiated. It is accomplished by means of four steel towers—two towers being used for each pole line. The length of span over this canal is about 132 feet. The distance between the bottom of the lowest transmission wire and the surface of the water in the canal is 148 feet. The top of each tower measures 16½ inches by 16½ inches, exclusive of the cross pieces which support the cross-arms.

Each tower is provided with a ladder and supports three sets of cross-arms, each consisting of four cross arms in one horizontal plane. One set of cross-arms rest on the top of the tower; the centre of the middle set is 36 inches below that of the highest and the centre of the lowest set is 30 inches below that of the second.

The wooden cross-arms on the towers are 13 feet long and the width across the four arms, making up a set, is about four feet. After leaving the towers at the Chambly canal, the transmission lines are carried on cedar poles between 40 and 45 feet long, set 5 feet in the ground and 90 feet apart. The pole line runs over the right-of-way of the Central Vermont railway, one pole line on each side of the track. At the Montreal end of the transmission line, the wires have to cross over the St. Lawrence river. The crossing is effected by carrying the wires over the top of the Victoria bridge on special fixtures. From the Victoria bridge the transmission lines run to a point about 4,000 feet from the sub-station, where other terminal houses are erected, similar to the ones at the Chambly end. The reason that the last 4,000 feet of the transmission line is underground is due to the fact that the Lachine canal has to be crossed.

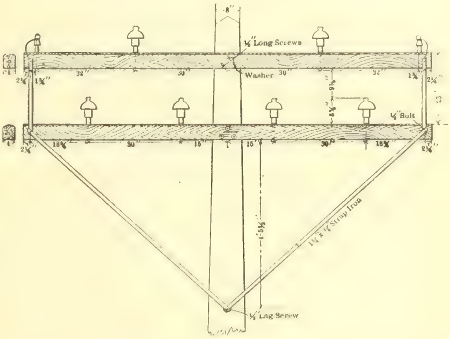


Fig. 4.—Pole with Cross Arms in Position, Chambly Transmission Line.

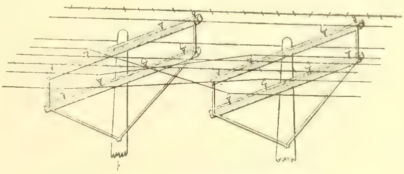


Fig. 6. Transposition Poles.

The transmission wire is of bare, medium drawn copper No. 00 B. & S. guage. Each circuit is arranged in the form of an equilateral triangle—30 inches centre. The cross-arms are Georgia pine—11 feet long x 4 inches thick and 5 inches wide, and were treated with a preservative. The pins which are used are hickory, boiled in stearine. The insulators used on the Chambly transmission lines are 6 inch porcelain Bock and Mershon type triple petticoat.

The H. T. cable contains three standard copper conductors of 221,000 c.m. cross section each. Paper saturated with compound is the only insulation in these cables. Outside of the paper is a lead sheath about 3-32 inches thick. The side of each conductor is about 7-16 inches distant from the lead sheath at the nearest point and the distance between the conductors themselves is 11-16 inches. The lead sheath of the cables contains about 3 per cent. of tin. The outside diameter of the cable is about 3 1-16 inches. The cable was manufactured and installed by the National Couduit & Cable Company, New York, N.Y.

The lightning protection for the Chambly transmission lines consists of barb wire. Three lines of barb wire are run on pony glass insulators on each pole line, two lines being run on the ends of the top cross-arms, 32 inches from the line wire, and the third on the top of the pole, the three barbed wires being joined together at each pole and grounded. In addition to this protection, Westinghouse low equivalent A. C. lightning arresters and choke coils are used—these banks of arresters being located at each end of the transmission lines in the terminal houses.

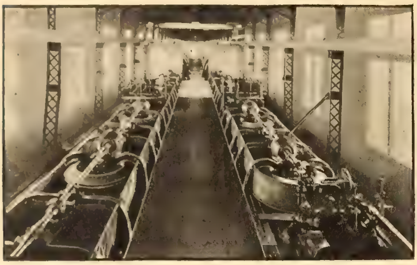


FIG. 7.—TURBINES, LACHINE POWER HOUSE.

The Chambly plant, it should be stated, is the result of reconstructing and doubling the capacity of the old plant, which operated at 12,000 volts, two-phase. The reconstruction was carried out by Mr. P. G. Gossler, the late general superintendent.

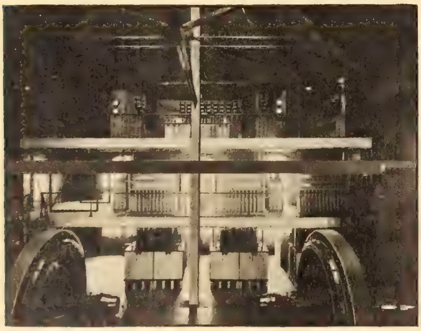


FIG. 8.—SWITCHBOARD GALLERIES, LACHINE POWER HOUSE.

THE LACHINE DEVELOPMENT.

The Lachine station of the Montreal Light, Heat & Power Company is situated on the Lachine rapids of the St. Lawrence, between the island of Montreal and the south bank of the stream. A large breakwater, about a mile in length, was constructed up and down through the rapids and a power station and dam was thrown across that portion of the river between the breakwater and the Montreal bank. The head of water thus secured is 16 feet. On account of the low head a number of single vertical shaft turbines were installed, six being used to drive each unit. The station is designed for a total of twelve units of 750 k.w. capacity each, though only eight are installed at present. Each generator having its horizontal shaft geared to six vertical wheels, it was thought desirable to arrange the generators in three groups, each group being two generators wide and two long. The power house is therefore a long narrow building, its dimensions being 1,000 feet long by 50 feet wide in the main part. The alternators are of C.G.E. manufacture and are rated at 750 k.w. and 5,000 volts three phase. The frequency is 60 cycles. Four exciting dynamos are provided for the alternators, each being rated at 75 k.w. and 90 to 175 volts and driven at a normal speed of 660 r.p.m. by a belt from a separate water wheel. The available head at this power house is subject to much variation, causing changes in the speeds of both the alternators and the exciters, and these changes must be compensated for by different currents and degrees of saturation in the alternator magnets, in order to maintain a constant alternating voltage.

FIG. 9.—FRONT VIEW CENTRAL STATION, MONTREAL.

The switchboard is of the bench board type and is arranged to control twelve generators and twelve outgoing circuits. Each circuit and each generator has its own oil switch, which is operated electrically from a controlling board on the second floor, the switches themselves being on the ground floor. On the first floor are three tie-in switches, by means of which the whole installation can be divided into four or less sections, so that it is possible to run four absolutely independent systems, each consisting of three generators and four outgoing circuits. On this platform are also knife switches in the circuits of both generators and feeders, so that the current can be entirely cut off from the oil switches in case any work is required to be done on these. The whole of the plant is entirely controlled from the board on the second floor and on this board there exists no pressure greater than 125 volts. This switchboard contains all controlling switches which are required for operating the main oil switches and for adjusting the current in the fields of the generators, and from here also the speed of either an individual unit or of two or more units simultaneously can be adjusted; indeed, the only operation which is not effected from this board is the starting up and shutting down of the turbines, which is done from the floor of the power-house by means of a signal system which is worked from the board.

As the distance from the Lachine power-house to the sub-stations in Montreal is only five miles, no step-up transformers are employed, the current being delivered at 5,000 volts to the overhead lines for transmission. There are two distinct pole lines, carrying a total of ten circuits, which terminate on the south side of the Lachine canal and are carried to the distributing station by means of 3-core paper-insulated cables. The wires of the transmission line are bare copper of No. 0 B. & S. guage and are arranged in the form of an equilateral triangle, 18 inches between wires. Six of the transmission circuits are carried on steel poles, the other four transmission circuits on cedar poles.

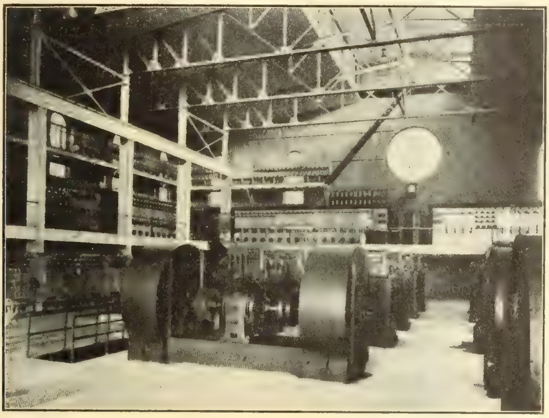


Fig. 10.—Interior View Central Station, Montreal.

A description and illustrations of the Shawinigan power station appear elsewhere in this number.

THE DISTRIBUTING STATIONS.

The Montreal Light, Heat and Power Company operate three sub-stations. At the McCord street station current from the plant at Lachine is received at 4,000 volts, three-phase, 63 cycles, and transformed for distribution to 2,400 volts. For this purpose there are nine air-blast transformers of 250 k. w. each, built by the Wagner Electric Company, and four of 1,000 k. w. built by the Canadian General Electric Company. One bank of the latter are connected so as to change the current from three-phase on the primary coils to two phase on the secondary coils.

The Shawinigan sub-station is situated in Maisonneuve, a suburb of Montreal. It receives the three-phase current at 44,000 volts and 30 cycles from two aluminum transmission lines, which current is subsequently delivered to the switchboard of the Montreal Light, Heat and Power Company, located in the station, at 63 cycles.

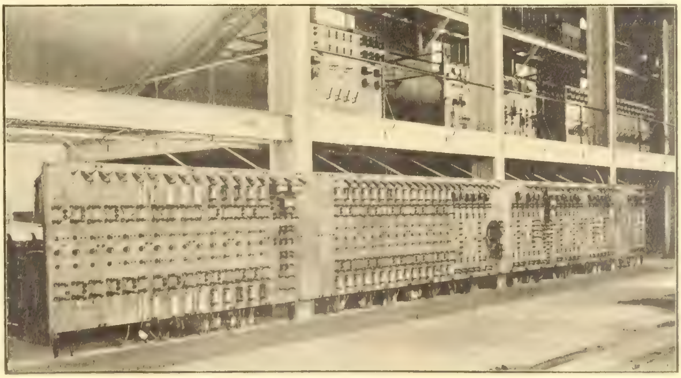


Fig. 11.—Switchboard, Central Station.

For the purpose of consolidating the great variety of systems which were in operation in Montreal, the company decided to build a modern transforming and distributing station. This is known as the Central station and is located near the centre of the city, in the block bounded by Ottawa, Wellington, Prince and William streets. It is constructed of brick and terra cotta and the interior measures 118x122 feet. To this sub-station come the high tension transmission lines of the Lachine, Chambly and Shawinigan systems. The four high-tension cables of the Chambly transmission line are brought to a selector knife switchboard similar to the one at the generating end of the line, the equipment including a 25,000 volt high tension, a 2,400 volt transformer switchboard and a 2,400 volt distributing feeder switchboard.

The high tension switchboard comprises four incoming lines and five transformer primary panels. The transformer switchboard comprises five operating and two total output panels. The distributing feeder switchboard comprises sixteen panels of 500 k. w. capacity each, and eleven panels of 1,000 k. w. capacity each, at 2,400 volts. The circuit breakers with which these panels are provided are automatic, the final break taking place in oil.

On the ground floor and immediately under the distributing switchboard is located a set of 27 circuit breakers, similar to those above. These are intended to handle grounded or defective circuits. This set is called the "emergency set." The high-tension switchboard is merely a selector board and its switches are only intended to open the transformer primaries under no secondary load conditions.

A noticeable feature of this equipment is the bank of voltage lowering transformers, ten in number. These are of the Westinghouse air-cooled type, no oil being used for insulating. They are the largest transformers in the world and weigh 24,000 pounds. The equipment of this station will ultimately consist of sixteen transformers of 2,750 k. w. each.

The transformers are permanently connected in pairs; the primaries three-phase 22,000 volts, the secondaries 2,400 or 4,800 volts two-phase, which is the system now in use by the Montreal Light, Heat & Power Company for distributing purposes.

There are also installed in this station 26 transformers of the natural air-cooled type of 30 k.w. capacity each, for operating the enclosed A.C. city arc lamps, the transformers taking the energy from the main transformers at 2,000 volts and stepping up to 4,800 volts. The A.C. arc light equipment of transformers and regulators was made by the Western Electric Company. About half of the D.C. load is distributed from this station. Synchronous motors connected to 250 volts D. C. generators furnish current for the three-wire 250 volts D.C. system. Ranged about three sides of the sub-station on a gallery and on the side, are the high and low tension switchboards which control and distribute the energy.

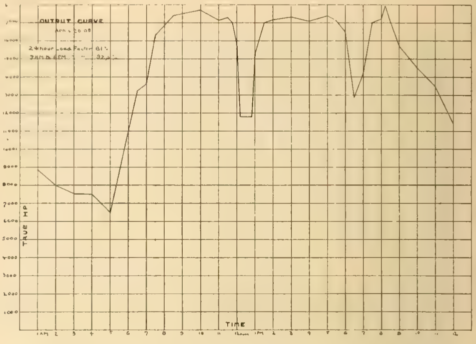
Mr. W. McLea Walbank,
Vice-President and Chief Engineer.

Current for the 250 and 500-volt, three-wire system, which operates direct-current motors, is supplied by two motor generators at the central sub-station. Each of these motor generators is made up of a 300 k.w. 2,400 volt, two-phase synchronous motor and a 250 k.w. 250 volt direct-current generator.

The Montreal Light, Heat & Power Company are rapidly carrying to completion the reconstruction and consolidation plans which where inaugurated a few years ago by Mr. P. G. Gossler, then general superintendent and engineer of the company, and for which he deserves much credit.

LIGHT AND POWER CONSUMPTION.

The rapid increase in the demand for light and power is an evidence of the successful management of the company. The total connected load of street lamps numbers 1,839 of the arc and 640 of the incandescent type. There are at present served 11,249 customers using commercial arc and incandescent lamps, who have connected to the system 328,219 incandescent lamps and 1,230 arc lamps, while power serv ce is rendered to 902 customers who employ 1,373 electric motors with an aggregate capacity of 257,101 h.p. Of the total number of arc street lamps, 1,839, the enclosed series alternating comprise 1,514, and the remaining 325 lamps are of the series open direct-current type. All of these street arc lamps are of nominal 2,000 c.p. each. The enclosed arcs operate nominally on 80 volts and 7.5 amperes each, or 480 actual watts. On the direct-current arc lines the rating is 9.6 amp.



Load Curve, Montreal Light, Heat & Power Company.

The two largest power customers of the Montreal Light, Heat & Power Company are the Dominion Cotton Mills Company, who have contracted for 3,000 h.p., and the Montreal Street Railway Company, who take about 5,000 h.p. The Wire and Cable Company, Dominion Oil Cloth Company, and Montreal Water and Power Company are other large users. The contracts with a number of the largest consumers provides for the disconnection of the motor load at 4 p.m. during the winter months, and the plan is said to be found very satisfactory. In this connection a study of the accompanying load curve of the central station taken on April 26th, 1905, will be found interesting.

Mr. W. McLea Walbank is the chief engineer of the Montreal Light, Heat and Power Company; Mr. R. M. Wilson, superintendent of stations; Mr. K. B. Thornton, superintendent of lines; Mr. J. M. Robertson, superintendent of repair shops; and Mr. R. S. Kelsch, Consulting Engineer

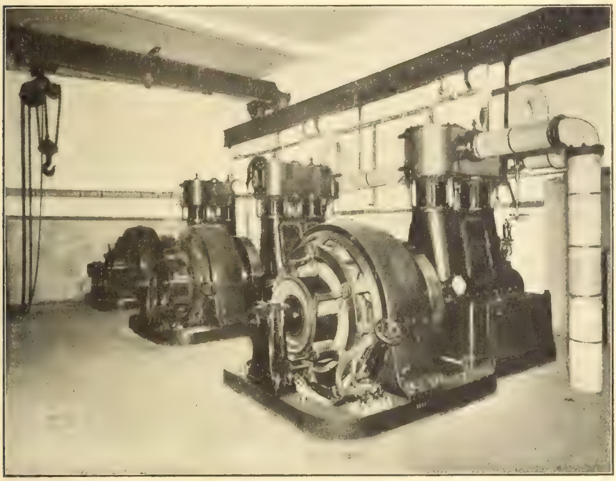
Mr. R. M. Wilson,
Superintendent of Stations.

Mr. K. B. Thornton,
Superintendent of Lines, and President Canadian Electrical Association.

Mr. J. M. Robertson,
Superintendent of Repair Shops.

THE CENTRAL ELECTRIC COMPANY, MONTREAL.

A plant which embodies several interesting features is that owned by the Central Electric Company and located at 95 St. Peter Street, Montreal. It is designed to supply electric light and power to private customers. For a distance of 85 feet on Notre Dame Street and 115 feet on St. Peter Street, the land has been excavated to 23 feet below the level of Notre Dame Street, the superstructures of the buildings being supported by massive foundations of stone, terra cotta and cement, and by steel pillars encased in terra cotta. By means of this excavation sufficient room has been provided for the installation by the Central Electric Company of a very neat and up-to-date electric plant. The original design of the enterprise was simply to supply the S. Carsley Company's dry goods establishment, but it was decided to extend the scope of the undertaking so as to supply power, light and heat within a limited area.



Engines and Dynamos, Central Electric Company's Plant.

The plant is interesting from the standpoint that it is almost exclusively of English manufacture. There are two Babcock & Wilcox boilers of 200 nominal horse power, equipped with Jones underfeed stokers, and it is the intention to install a third boiler in the near future. In the engine room are to be found three self-lubricating engines of 225 h.p. nominal capacity guaranteed to 25 per cent. overload without undue heating. These were installed by the Belliss & Morcom Engine Company, of Birmingham, Eng. They are direct-connected to dynamos producing 220 volts direct current, the latter being manufactured by the General Electric Company, of Manchester, Witton, and Birmingham, England. The self-lubrication of these engines is a feature of interest, and the absence of vibration is also noticeable.

There is also a balancer set, installed by Fred Thompson & Company, of Montreal.

The switchboard is constructed of Vermont grey marble, and contains, in addition to the switches, the necessary voltmeters, ammeters, wattmeters and circuit-breakers, as well as the instruments for the balancer set. The Hill Electric Switch Company supplied and installed this board with the exception of the panel on the right containing the instruments for the balancer set, which was furnished by Fred Thompson & Company.

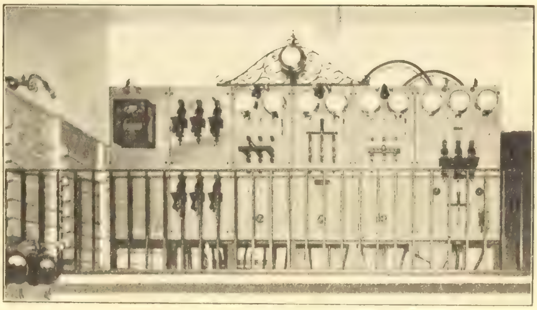
Under the switchboard are placed the feed water heaters, which take the city water and by forcing exhaust steam through it deliver it to the feed pumps of the boilers at a temperature of 210 degrees Farenheit. The feed pumps are guaranteed to take care of 450 horse power against 150 pounds pressure. The floor of the power house being considerably below the level of the city sewerage system, pumps are provided to assist the drainage.

Space has been provided for largely increasing the plant, and it is probable that another generating unit will be installed in the near future.

There is a motor driving an 80 h.p. alternator which is used to supply the current for some of the arc lamps in the Carsley store.

A travelling crane with a capacity of ten tons has been provided.

The president of the Central Electric Company is Mr. S. Carsley, and the manager Mr. Charles Morton, formerly of the Standard Light & Power Company. The plant was designed by Mr. D. S. Barton, manager of the Canadian Electric Company, of Levis, Que., and was installed under the direction of Mr. W. C. Wormington, C. E.



Switchboard, Central Electric Company's Plant.

The Town Council of Galt, Ont., are considering a proposition looking to the installation of a municipal electric light plant

The City Council of Winnipeg, Man., are inviting proposals for the supply of electrical power, the maximum quantity to be used at any time to be to be 1,500 horse power. Offers will be received simultaneously from parties who own water powers for the sale to the city of such water power. The tenders are to be received by June 12th.

THE SHAWINIGAN WATER AND POWER COMPANY

A complete description of the magnificent power development works of the Shawinigan Water & Power Company appeared in the December, 1904, issue of the ELECTRICAL NEWS, but as the programme of the C.E.A. Convention may include a trip to Shawinigan Falls, we will again refer briefly to the more important features of the plant.

Shawinigan Falls is situated on the St. Maurice river 85 miles from Montreal, to which point electric power is transmitted. This river drains an area of about 18,000 square miles. Numerous lakes store the waters to such an extent that the flow of the river is very regular and seldom falls below 10,000 feet per second, which, under the available head of about 140 feet, is sufficient to produce upwards of 100,000 horse power. In making the power development the water was taken out of the comparatively narrow channel of the river and the location of the canal was decided upon with a view to avoiding trouble from anchor ice. The canal is about 1,000 feet in length, 100 feet wide and 20 feet deep. On top of the forebay wall a brick gate house has been constructed in which is installed cylinders for raising and lowering the head gates closing the upper end of the penstocks. This hydraulic mechanism is designed to work under a maximum pressure of 800 pounds per square inch and successfully operates the steel head gates under pressure of 40 feet head of water.

The power house, shown in the illustration, is of solid concrete construction up to the windows, and from that point the walls are of brick 24 inches in thickness. Four penstocks 9 feet in diameter have been installed, one of these leading to the power house belonging to the Northern Aluminum Company, and the other three to the main power house of the Shawinigan Water & Power Company. Another penstock 3 feet 6 inches in diameter conveys the water for operating separate turbines of 500 h. p. each for driving the exciters.

There are installed in the power house three pairs of "Francis" turbines on a horizontal shaft, operating at a speed of 180 r.p.m. and capable of delivering 6,000 h.p. Two of these were installed by the I. P. Morris Company, of Philadelphia, and one by Escher, Wyss & Company, of Zurich. To each of these three turbines is direct connected a 3,750 k.w., two-phase, 2,200-volt generator, two of which were built by the Westinghouse Electric & Manufacturing Company, of Pittsburg, and a third by Dick, Kerr & Company, of London. The above constituted the initial installation. There has recently been installed, however, a fourth and still larger unit, consisting of a 10,500 h.p. water wheel manufactured by the I. P. Morris Company, connected to a 6,600 k. w. Westinghouse generator. To 500 h.p. wheels are connected direct-current generators of 400 k.w. capacity at 125 volts, which are used as exciters. The current from these exciting generators is conducted over aluminum bus-bars from the generator to the exciter panels, located as are the balance of the panels upon a switchboard gallery running the entire length of the building.

The current from each generator is conducted to the generator switch by paper-insulated lead covered cables in tile ducts built into the floor. The oil switches are of the solenoid type and work very rapidly. The cables pass from the oil switches to a selector switch, by means of which the current can be thrown on to either one of the two sets of bus-bars, the plan

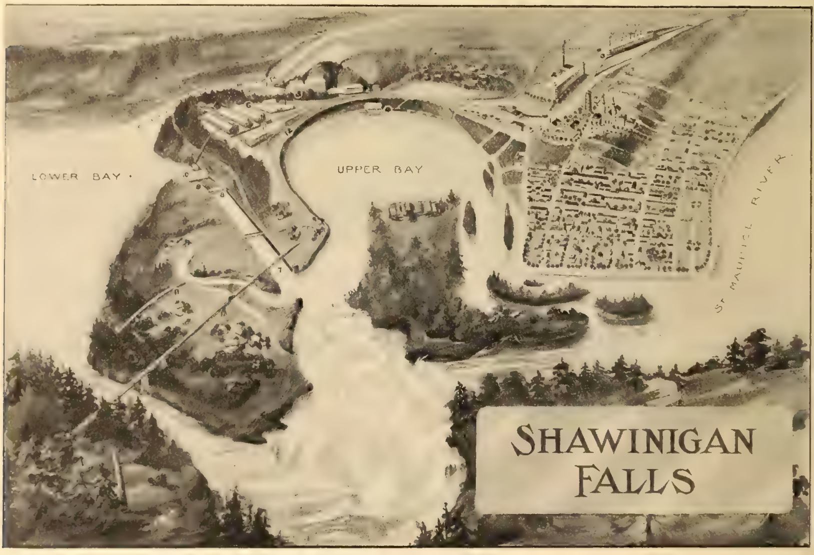


FIG. 1—WATER POWER DEVELOPMENT AT SHAWINIGAN FALLS.

1—Hotel.
2—Liner Mill.
3—Carbide Works.
4—Second Development.
5—Pulp and Paper Mill.
6—Aluminum Works.
7—Canal.
8—Bulkhead.
9—Penstocks.
10—Power House.
11—Log Slide.
12—Electric Railway.

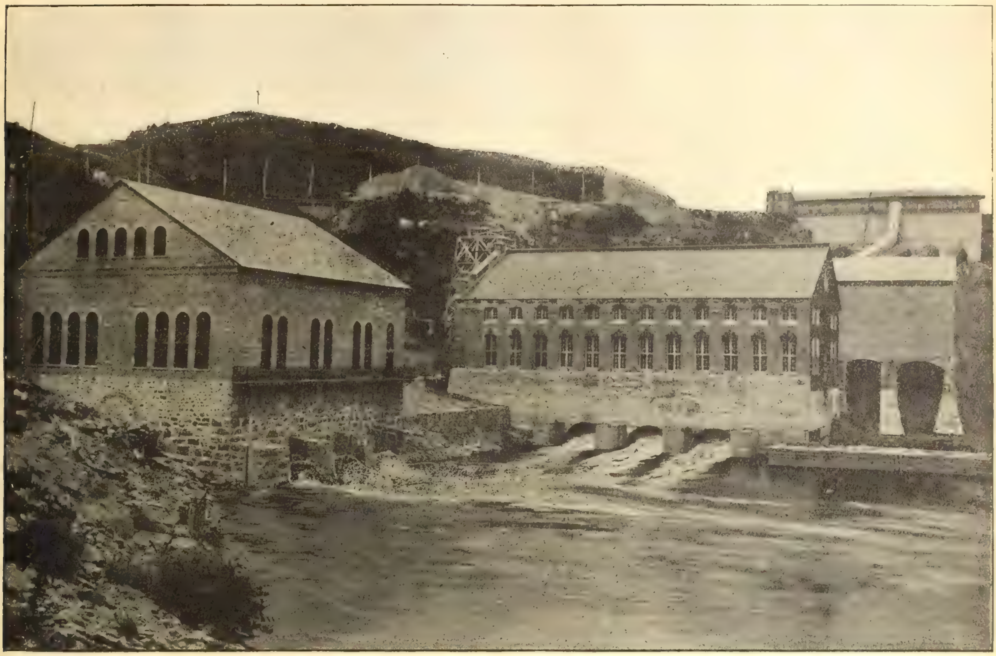


Fig. 2.—Shawinigan Power House and Tail Race.

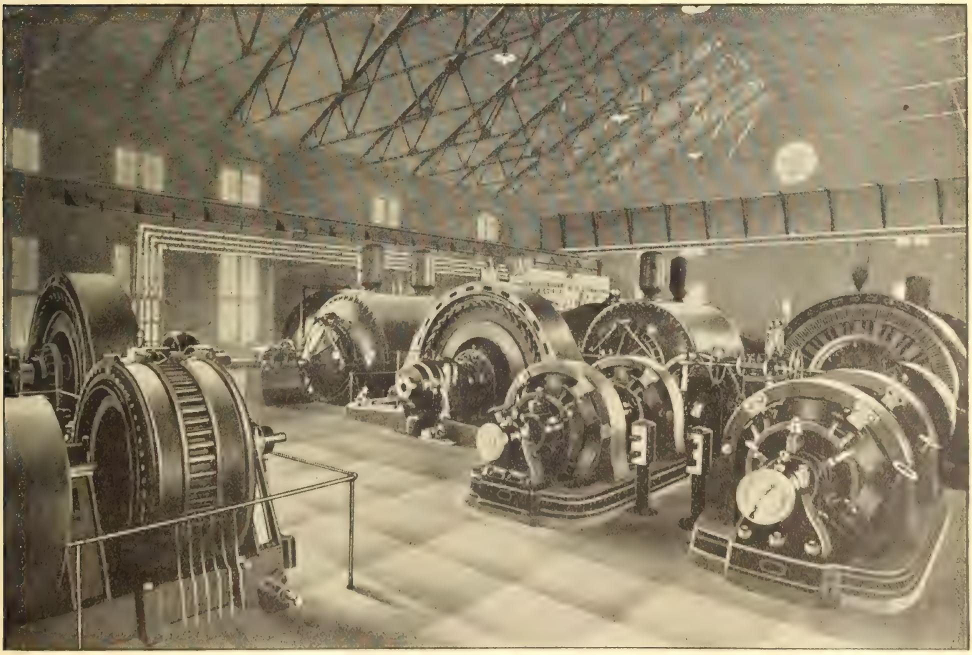


Fig. 3. Interior of Shawinigan Power House.

being to separate the load which is subject to fluctuations from the more steady load by means of two sets of bus-bars. From one set of bus-bars current is taken to the local distributing board, through which the 2,200 volt current is distributed to the electric lighting system and small local power users. The current for larger factories located within a distance of 20 miles from the power house, is conducted from the bus-bars through oil switches to step-up transformers, by which it is raised to 25,000 volts, two-phase. The current designed for transmitting a greater distance is in a similar manner stepped-up to 50,000 volts three-phase, this being the pressure employed on the transmission lines to Montreal. The transformers are located in a separate building, in which are also the lightning arresters, static interrupters and high-tension switches. The transformers are of the oil-insulated, water cooled type having a rated capacity of 1,100 k.w.

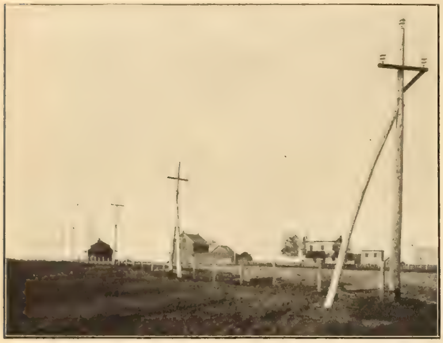


Fig. 4 Shawinigan Transmission Line.

The Northern Aluminum Company purchase the water at their power house and have installed their own wheels and generators, which consist of three pairs of 2,500 h.p. turbines each direct-connected to a 1,000 k.w. generator producing continuous current at 300 volts. The Shawinigan Carbide Company take power in the form of alternating current at 25,000 volts from the transmission line specially constructed for this purpose. This current is reduced by means of step-down transformers to 75 volts, their electrical equipment consisting of twelve 300 k.w. oil-filled, self-cooling transformers and two 175 k.w. power transformers for driving motors, etc., around the building. The Electro Manganese Company is also a large user of electric power in the manufacture of high grade steels.

The exact distance from the generating station at Shawinigan Falls to the terminal station in Montreal is 84.3 miles. The first transmission line constructed consists of three aluminum cables each composed of seven No. 6 B. & S. wires. These wires are spaced 60 inches apart, in the form of an equilateral triangle, with the apex above, as shown in the illustration. The power line is transposed twice in its entire length, each transposition being one-third of a complete turn. A second transmission line has recently been completed similar to the one described, except that the cables are composed of seven strands of No. 4 wire.

From the main transmission line at Joliette, a town located 35 miles from Montreal, current is taken off to a sub-station and stepped down to 25,000 volts and carried by a transmission line and submarine cable across the St. Lawrence river.

At the terminal station in Montreal current is taken through lightning arresters and static interrupters to

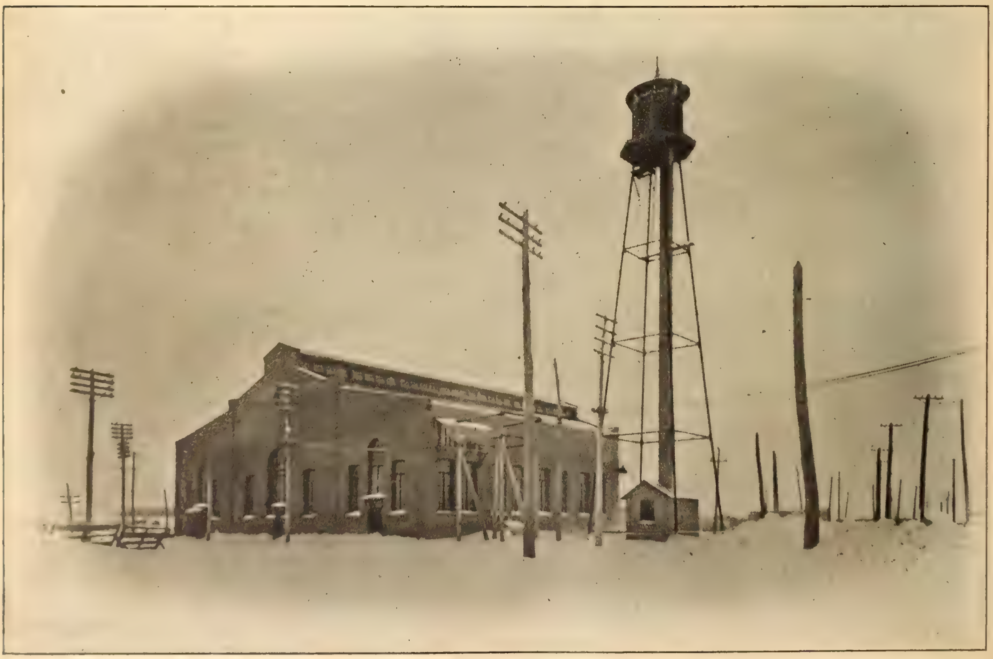


Fig. 5 Shawinigan Terminal Station, Montreal.

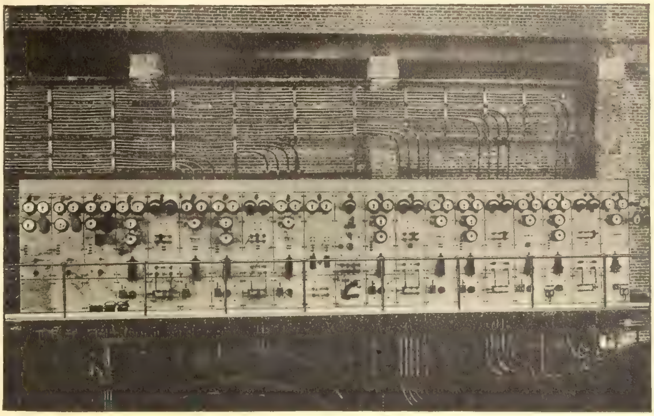


Fig. 6—Switchboard in Terminal Station, Montreal.

step-down transformers of 1,000 k. w. capacity designed to reduce the current to 2,400 volts. As the company contracted to deliver to the Montreal Light, Heat & Power Company current at 60 cycles, it was necessary to install motor generators to change the frequency. The first installation consisted of five 1,200 h. p. frequency changers, built for the contractors by the Bullock Electric Manufacturing Company, of Cincinnati, and consisting of a three-phase, 30 cycle, 2,400 volt synchronous motor, direct-connected to a three-phase, 2,400 volt, 60 cycle generator. In this station there is also installed an 8,000 h. p. frequency changer. It consists of a 5,750 k. w. alternating current generator, an 8,000 h. p. synchronous motor and a direct-connected induction motor for starting purposes. The total weight of this set is almost 500,000 pounds ; the motor is capable of developing a maximum starting torque equivalent to 2,500 h. p. This set completed the contract of Allis-Chalmers-Bullock, Limited, Montreal, for the installation of the machinery in the sub-station necessary to convert the alternating current to meet the requirements of the city. In addition to the machines mentioned, there are installed in this station the following Allis-Chalmers-Bullock apparatus : One 100 h. p. 2200 volt induction motor, direct connected to a 60 k. w. d. c. generator ; one 30 h. p. 220 volt induction motor for driving blowers ; one 10 h. p. 220 volt induction motor for driving duplex pump ; one 18 h. p. vertical induction motor ; and two 800 k. w. rotary converters in connection with two 900 k.w. three-phase transformers.

The switchboard for controlling the transformers and frequency changers is mounted on a gallery extending from one side of the motor generator room. Current is conducted from the transformer through the oil switches to 30 cycles bus bar, from which the current is taken for each motor through oil switches installed in the basement on lead covered cables. From the generators the current is conducted through oil switches and lead covered cables to knife switches, which may be connected to either of two sets of bus-bars, and from these bus-bars to the bus-bars of the Montreal Light, Heat & Power Company in their adjacent distributing room.

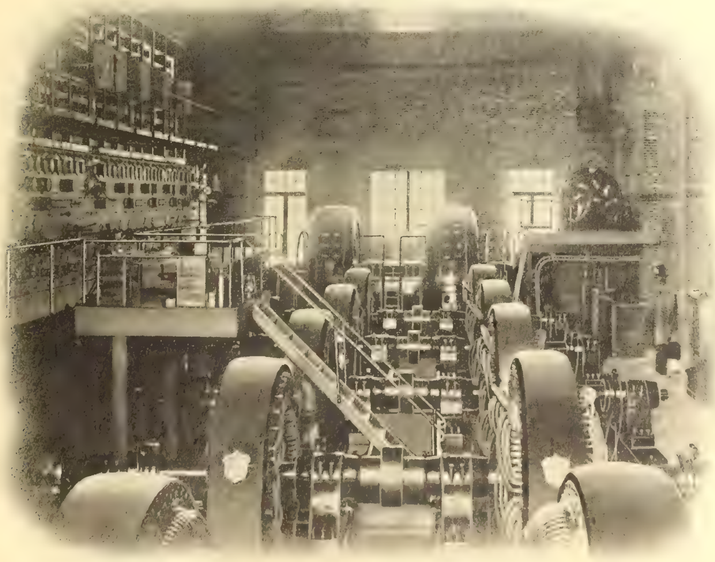


Fig. 7 Interior of Terminal Station, Montreal.

The consulting engineer for the company is Mr. Wallace C. Johnson, from whose plans the work was executed. Hon. Robert Mackay is president of the company ; Mr. Howard Murray, secretary ; and Mr. Julien C. Smith, superintendent. In addition to the companies mentioned, the Canadian General Electric Co., also furnished some of the electrical equipment.

POWER PLANT OF THE C. P. R. SHOPS, MONTREAL

The "Angus" locomotive and car shops of the Canadian Pacific Railway, situated in Hochelaga Ward, Montreal, and which are designed to maintain the rolling stock on the eastern part of the system, are among the largest and most complete establishments of the kind on the continent. The whole plant occupies a rectangular plot of ground about 4,700 feet long and 2,000 feet wide. The buildings in general are arranged on either side of the centre passage or midway, over which is located a ten-ton crane running on structural steel supports.

That the demands upon the power plant may be somewhat understood, we will give the dimensions of the different buildings, which are as follows: Locomotive shop, 163x1168 ft.; grey iron foundry, 342x122 ft.; storehouse, 85x94 ft.; pattern shop, 50x82 ft.; blacksmith shop, 433x146 ft.; car machine shop, 130x288 ft.; truck shop, 82x434 ft.; wheel foundry, 107x197 ft.; freight car shop, 107x540 ft.; planing mill, 126x500 ft.; two passenger car shops, each 100x672 ft.; cabinet shop, 62x581 ft.; and frog and switch shop, 116x263 ft.

Perhaps the most interesting feature of the power plant is the use of alternating current in connection with induction motors for nearly all the machine tool drives. After carefully considering the advantages of the different systems, it was finally decided that as far as possible all the demands should be met by alternating current, and direct current employed only where the alternating current service was not considered practical.

The power house is a brick and steel structure, 103x163 feet, divided into two parts by a brick center wall.

In the boiler room there are seven Babcock & Wilcox boilers, carrying 160 lbs. pressure, each of 416 h.p. capacity, and one 320 h. p. high-pressure boiler, which will carry 300 lbs. working pressure. This latter boiler is to be used for testing locomotive boilers in the boiler shop, and has a separate pipe line running through the tunnel for this purpose.

The shavings and refuse from the planing mill are used to a large extent for fuel, and for this reason part of the boilers which are connected to the shaving tower are hand fired, and others, which use coal exclusively, are equipped with automatic stokers. All the boilers are fitted with a B. & W. patent superheater to superheat the steam to 150 degs. F. There are two Green economizers of 480 pipes for heating the feed water. The draft is obtained from two 200-inch steel plate fans located on a platform supported by a steel frame work above the economizer in the center of the boiler room. Each fan is direct-connected to a double enclosed Navy type vertical engine 5½x8 ins. The fans discharge into a steel stack 8 ft. in diameter and 70 ft. high. On the boilers which are stoked by hand Neemes shaking grates are used.

The boiler feed pumps, furnished by the Canada Foundry Company, are located in the pump pit in the engine room. There are two low-pressure pumps delivering at 160 lbs., and two high-pressure delivering at 300 lbs., the latter for use in connection with the high-pressure boiler. In this same pit are also two Underwriters 5,000-gal. fire pumps; two water pumps for supplying the tank and an automatic oil pump for the forced lubrication. The boiler feed pumps take their supply from the hot well, into which the condensation from the heating coils is delivered, and discharge through the economizer to the boilers.

The boilers are connected to a large 12-in. steam header by 7-in. pipes rising directly from the top of the superheater through a large bend and valve to the header connection. The header is located on the boiler-room side of the wall dividing the power house. The high-pressure boiler also connects to this header through a reducing valve so that it may be used for furnishing the power house engines when not required for testing. The engines connect to this header by a 7 in. pipe, having an easy bend. There is a valve at the header connection and a steam separator at the engine. The condensation from the engines and piping is returned

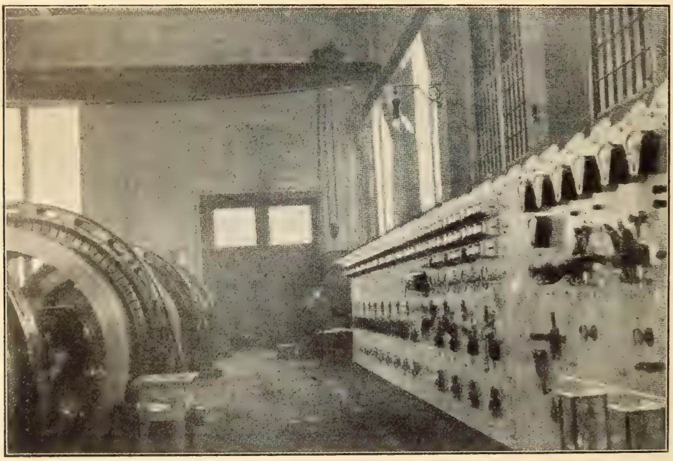


FIG. 1.—VIEW IN POWER HOUSE, SHOWING SWITCHBOARD, C. P. R. SHOPS, MONTREAL.

to the boilers through the Holly loop system. In the engine room are three 750 h. p. direct-connected units, consisting of cross-compound Corliss engines 21 and 33x24 ins., built by the Robb Engineering Company, of Amherst, N. S., and a 500 k. w. three-phase 300 volt alternating current generator furnished by the Canadian General Electric Company. There is also a 375 h. p. simple engine 18x24 ins., direct-connected to a 250 k. w. C. G. E. three-phase generator. The direct curent for the cranes and variable-speed machinery is obtained from two 200 k. w. 250-volt direct-current generators, driven by 18x20-in. h. p. simple engines. The direct-current machines connect directly to an outside circuit, which consists of one set of cables, each composed of two 250,000 C. M. wires.

The switchboard, shown in the illustration reproduced from the Railway and Engineering Review, is of blue Vermont marble and has separate panels for each of the generators and outside circuits, with the instruments connected to each. There is also one spare panel to permit of the installation of another unit. Back of the switchboard is a pit, into which all the wiring is carried.

The outside alternating current circuits, of which there are 10, each connect to a cable, which is carried to the top of a tower. From this tower the leads are carried through the bare copper wires on steel poles to the different shop connections.

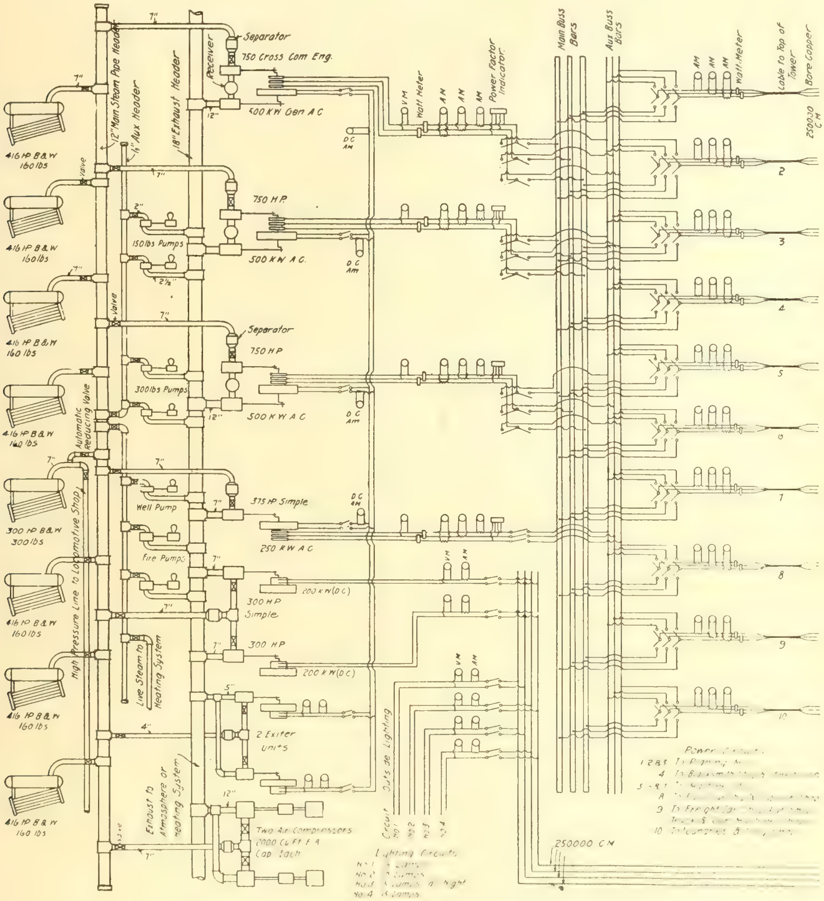


FIG. 2.—POWER DISTRIBUTION IN POWER HOUSE, C. P. R. SHOPS, MONTREAL.

There are also two 11x12 in. simple engines driving the exciter units. The two compound air compressors are of 2,000 cu. ft. free air capacity and furnish a pressure of 100 lbs.

The electrical connections from the alternating generators are carried through the usual switchboard instruments to a double throw three-pole switch. One side of this switch connects to the main bus bars and the other side to the auxiliary bus bars. The connections to the outside circuits are also made through a similar double-throw switch. This gives a very flexible arrangement, allowing any generator to be placed independently on any circuit or any combination of units.

There are three alternating currect and one direct-current circuits from the power house entering the machine shop. Each circuit comes to a large distributing board direct, from which several circuits are taken. Each of these smaller circuits serve approximately 100 h.p. of motor capacity. The leads are taken from the distributing board, which is located in a gallery, above and outside the machine gallery, by three heavy insulated wires carried on porcelain insulators along the roof truss. The different motor

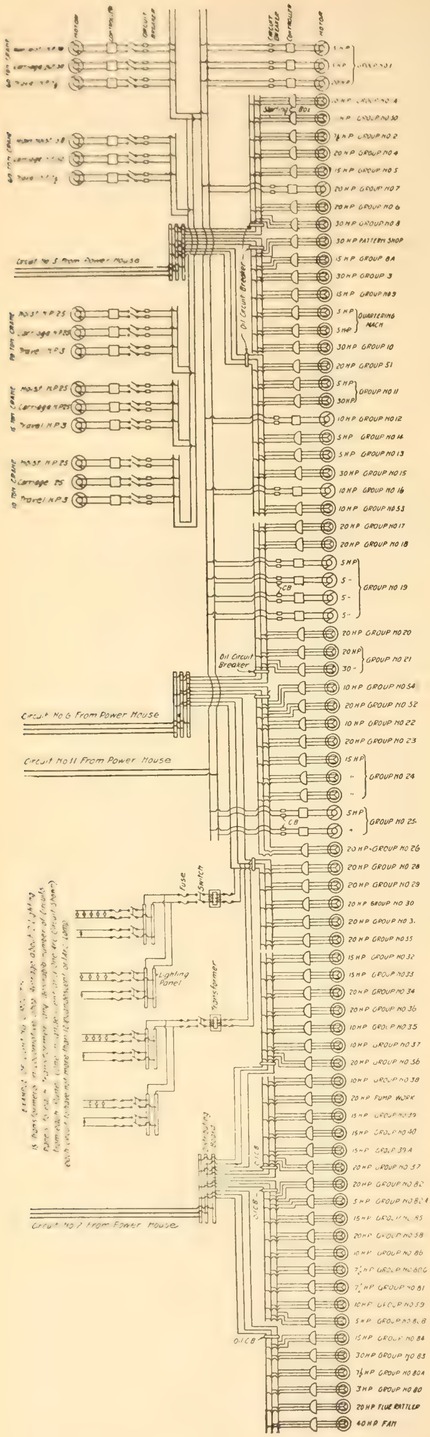


FIG. 3--ELECTRICAL DISTRIBUTION IN LOCOMOTIVE SHOPS, C. P. R. SHOPS, MONTREAL.

connections are made directly to these leads at the most convenient point. On each lead, just before the first motor connection is taken off, is located an oil circuit breaker in a convenient position. There are no fuses, switches or other instruments in this circuit up to this circuit breaker. The leads to the motors are carried through piping down the posts or walls to the starting box of the motor. This starting box is arranged in the form of a street railway controller, and each notch cuts out resistance as the motor gains in speed. As it is necessary to allow an induction motor to attain its speed before cutting out more resistance, the workmen have been trained to judge by the hum of the motor when to throw the controller another notch. There is a no-voltage release at each oil circuit breaker.

The direct-current machines, of which there are comparatively few, are taken from a circuit running the full length of the building, at the nearest available point. They have variable speed controlling boxes and circuit breakers located in each machine. All crane motors are connected to this direct-current circuit.

The lighting circuits are taken from the three-phase line through transformers to the lighting points. The tranformers are arranged in pairs, one being connected to wires 1 and 2, and the other to wires 2 and 3. The transformers change the voltage from 550 volts to 110 volts. The light-distributing boards, or panels, contain two copper bus bars, from which the several lighting circuits are carried through fuses and switches. Each of these small circuits carries not more than one enclosed arc, or 12 incandescent lights or light receptacles. There are 15 transformers in the locomotive shop, and 29 lighting panels. The lighting in the erecting shop is mostly by arcs hung from the roof trusses and with incandescents along the side walls, while that in the machine shop is principally by incandescent lights. There are plug receptacles located at short distances in all pits and along posts, as well as at benches and any other place where they may possibly be needed. Fig. 3 shows the electrical distribution for the locomotive shop.

The electrical distribution and lighting circuits for each shop is on the same order as that shown for the locomotive shop in Fig. 3.

The combined rated h.p. of the alternating current motors for the different shops is of considerable interest, and is given below:

Locomotive shop	1,074
Planing mill	1,750
Cabinet shop	250
Blacksmith shop	705
Car machine shop	245
Frog and switch shop	130
Truck shop	142
Wheel foundry	70
Transfer table	20
Total	4,386

In the power house there are alternating current generators to the capacity of 1,750 k.w., driven by engines of a total capacity of 2,625 h.p. This gives a power house equipment of about 46 per cent. of the total motor h.p., in electrical h.p. and 56 per cent. in engine h.p. This should prevent a serious overload at the power house under almost any conceivable circumstance.

Messrs. Ross & Holgate, of Montreal, were the consulting engineers for the installation of the power plant.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS :

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Ques. No. 1.—What is angular velocity, and what has it to do with the running of alternating current generators?

Ans.—With a double acting single cylinder steam engine, the crank, when on the dead centres, communicates no turning motion to the shaft, and therefore the energy stored up in the fly-wheel is actually driving the connected machinery at this instant. When the crank is either up or down, and at right angles to the piston rod, the turning effort is greatest and energy over and above that required by the driven machinery is stored up in the fly-wheel. From this you will see that the speed of the shaft is inclined to vary a little four times during each single revolution, being a maximum when the crank is up or down, and being a minimum as the crank passes the centres. If there are two engines of the type mentioned above, each direct-connected to an alternator, and the machines are synchronized when the engine cranks are at right angles to each other, one generator will be speeding up when the other is slowing down. At the end of the next quarter of a revolution the first machine will be slowing while the second will be accelerating. A quite heavy current is apt to flow between the machines if this action be marked, the direction of flow being from the machine speeding up to the one slowing down. This action may be of a very serious nature, for while such current is "wattless" it will nevertheless produce heating in both machines, and necessarily absorbs a certain amount of the current capacity of each. Using single cylinder engines, the difficulty is overcome by synchronizing the generators when the cranks of the two engines are in relatively the same position, that is, both engines will be speeding up at the same instant, and slowing down at the same instant. On the 5,000-k. w. generators in the New York Metropolitan Station, the shaft receives eight impulses per revolution (there are four double-acting cylinders in each engine) and consequently no trouble is experienced, the angular velocity being practically constant. On steam turbines and water wheels, the turning effort is, of course, steady at all points and therefore the question does not enter at all.

Ques. No. 2.—Give a formula for determining the maximum current permissible for any size of tinned iron wire, when used in embedded electric heaters; also a formula for finding the length of wire for a given current and voltage.

Ans.—The formula for the maximum current will vary greatly according to the substance used for embedding, thickness of substance, ratio of radiating surfaces to amount of energy used in heater, and several other items. If you are going to construct a heater, possibly the formula for the fusing point of iron wire will be of service :

$$d \left(\frac{I}{a}\right)^{2/3}$$

where d is the diameter of the wire in inches ; I is the current in amperes ; and a is a constant, which for iron wire equals 3,148; Of course a current sufficiently heavy to fuse the wire should not be used, but the value rather should be from one-quarter to one-half of this amount. For instance, if you wanted to construct a heater for 10 amperes, at a potential of 110 volts, you would find from the above formula that 10 amperes is sufficient to fuse an iron wire 0.0216 inches in diameter. This wire has an area of approximately 466 C. M., and taking a size so that ten amperes would be one-quarter of the fusing current, we get an area of 1,864 circular mils, and the nearest size of wire to this is 18 (Trenton gauge) which contains 2,025 circular mils. The resistance of iron wire per mil foot is 58 ohms, at 0° C. The formula for arriving at the final temperature of the wire, and its final resistance, is rather complicated but speaking roughly the final resistance may be taken as 174 ohms per mil foot. Therefore the final resistance per foot of the wire we have selected will be 0.086 ohms. As we wish to use a current of ten amperes, with a voltage of 110, the resistance of the circuit must be 11 ohms. Therefore approximately 128 feet of the wire will be needed.

Ques. No. 3.—(a) What governs the limit of excitation current over normal in synchronous motors ? (b) What are the effects on the synchronous motor when over or under-excited ?

Ans.—Taking up question (b) first, we have the following condition : the motor runs in step with the supplying generator (except of course when the load becomes so great as to pull it out of step, at which point it will stop) and varying the field strength has no effect upon the speed. Assume that the machine is running and then the field current can be adjusted so that the current taken by the armature is at a minimum. In this condition the power factor is 100. If now we strengthen the field, the current in the armature increases also, first slowly per step of the rheostat, and then with greater rapidity. The power factor drops down from 100, and the current in the armature *leads* the impressed voltage. If we lower the field current, the same effect is noticed, that is, the armature current increases, but with the field below the "normal" point, the armature current *lags behind* the impressed voltage, and the power factor again falls below 100. In this way, the motor can be made to draw full load current from the line, by over or under-exciting the field, and the machine can draw this full load current even though it be running idle. This same variation of current can be produced by changing the field strength when the motor is carrying a load ; hence the advantage of using some synchronous motors where a large number of induction motors are also run—the synchronous machine can correct the lagging current produced by the induction motors, and the power factor in the transmission line can be made 100. (a) When a synchronous motor is running light or loaded with normal field, the iron losses remain practically constant, and therefore the heating from this source is also constant. As, by varying the field excitation, the machine can be made to draw full load current and over, the copper losses, and consequent heating from this source, can be made to equal full load heating. As a matter of fact, the heating with full load current when the machine is carrying no load is really greater than if running under actual full load with the power factor at unity, because, under such conditions, the immense lag or lead requires a strong field excitation, and hence the heating from the field coils proper, and the additional iron heating is greater. Therefore, the limiting feature of over or under-excitation is simply the heating of all parts of the machine.

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China's First Patent. A report has been issued by the several German papers to the effect that the Government of the Empire of China has at last recognized the right of the inventor to the product of his brain, and has accordingly granted its first patent, said patent covering a branch of the electric art. The inventor hails from the old Chinese Capital, Nanking, and his invention is of an electric lamp, which he calls "bright moonlight," and which, he asserts in his claim, is far superior to the foreign glow lamps hitherto sold at Shanghai and other Chinese cities. It would be interesting to know the construction of this lamp, and also how the inventor has solved the much discussed question of horizontal versus downward candlepower. The Chinese nation is slow, according to our Western ideas, but as a matter of fact it commenced business and was civilized some few odd thousand years before the date of our oldest European record, and who knows but that the idea embodied in this "bright moonlight" lamp has been handed down for many hundreds of years, from generation to generation, each working upon and carrying the development a step forward, until the article first to receive official recognition by the Celestial Kingdom is now little short of perfection. Were this really so, it would be far from strange, for it is upon this basis that the Chinaman works; what he knows he keeps very much to himself, until the time, when on his death-bed, he gives his ideas to his eldest son, who, in his turn, preserves the same protecting secrecy as his parent did before him. The civilization of China is a marvelously developed one, and the national religion has stood intact since the days of Confucius. If all the Celestial knowledge were suddenly thrown open to the world, it would indeed be a severe blow to the self-sufficient peoples of the West.

Niagara. So much has been said and written concerning the destruction of Niagara that it may interest our readers to know that when all the companies, now in operation, being built, or still on paper, are running, not more than twenty per cent. of the total water of the river will be required. It is very good for people to have the æsthetic side of their natures well developed, but some things can be carried so far that they become absurd, and such a classification is quite suitable for the premature cryings on this Niagara question. The Falls represent to the people of Ontario and New York State, one of their most valuable assets. It is without a single exception the greatest water power in the world, and is in proportion beautiful, but beauty alone as an asset does not count for very much. We would not advocate for a moment the giving of all the water in the Niagara River for commercial purposes, but it is our idea that all the power which can possibly be developed without marring the beauty of the Falls, should be developed, and distributed throughout the surrounding country for the everlasting benefit of the community in general. Let those whose aim is the preservation of the Falls devote some of their energies to the abolition of the hideous structures which are now to be seen along the banks of the river below the Falls proper, and their work will not be without reward. The two power houses on the American side, and the three being constructed on the Canadian side, will be credits in keeping with the natural grandeur of the section ; such cannot be said of the poorly constructed and disreputable looking factories and cheap amusement houses which now stand out with altogether too much prominence. Here is a field for good work, and one much more sensible than the uncalled-for battling against solid commercial enterprises, whose schemes are for the ultimate benefit of the entire Dominion.

High Tension Direct Currents.

In a previous issue we made comment upon the 70,000 volt direct current transmission plant recently put into operation between St. Maurice and Lausanne, in Europe. Evidently the success with which this equipment has met has been such as to warrant the installation of another high tension direct current system, and it is a notable fact that this second plant is also in Europe, and not in America, in spite of the many boasts of progressiveness which this continent has made. A curious feature of this new system, which extends from Montiers to Lyons, a distance of 112 miles, is that a constant current is used, the power transmitted being varied by automatic changes in the voltage at the power house end. To all intents and purposes, it is a series direct current equipment, the generators all being series wound. The engineers in charge of the designing of this plant gave due consideration to all the various schemes which presented themselves, and the adoption of direct current at a high potential seems to indicate that when the engineers of America become sufficiently educated, we may expect some momentous changes in existing equipments on this side of the water. About 6,300 horse power was required at Lyons, part of this energy being for the 600 volt direct current street railway system, and the balance to feed the existing three-phase alternating system, the pressure of which is 25,000 volts. This latter system is fed, we should judge, from a steam plant,for in our data on the equipment, we find the note that the motor-generator sets in the sub-stations are reversible, and that the three-phase alternating system is thus able to feed the high tension direct current lines. This feature is very worthy of note, for this is the first instance where two generating stations of such dissimilarity, and such a distance apart, have been designed so that in case of an emergency, either may supply energy. In the power house at Montiers, there are four generating sets, each consisting of two generators driven by a water wheel. Thus in all there are eight dynamos, each of which has an output of 75 amperes, and wound for producing a potential of 7,200 volts. As previously noted, the machines are series wound, and when the eight generators are connected in series, the output of the station will be 75 amperes, at 57,600 volts, or 4,320 kilowatts. The machines are of the six pole type, and the regulating feature consists of varying their speed in proportion to the load carried, the highest speed being in the neighborhood of 300 revolutions per minute. Simplicity has evidently been a very much considered point in the design of the whole equipment, for in the power house there is no switchboard to speak of, beyond a voltmeter, ammeter, and main switch for each machine, and the speed governor. Lightning arresters are, of course, placed on the outgoing line, which runs overhead almost all the distance. About two miles outside of Lyons, it dips underground, and is thus carried to the substation. At the change from overhead, lightning arresters are also installed. The line proper consists of two copper wires, each of which corresponds to a size somewhere between the 00 and 0 sizes of our standard gauge. At the street railway substation, motor-generator sets are installed of 500 kilowatts capacity each, the motors being of the same type as the generators at Montiers, and the generators being wound for a constant potential of 600 volts direct current. In the sub-station which feeds the existing alternating system, motor-generator sets are also used, the motors being the same as for the street railway station, and the generators being of the three-phase, revolving field, alternating type. It is this equipment of sets which can be reversed, if the occasion arise, the generators being fed for alternating current and running as synchronous motors, and the series direct current motors having their connections changed and running as generators. The central point of the series of generators at Montiers is connected to ground, and the corresponding points at the substations at Lyons are treated in a similar manner, this reducing the potential from either line to earth to about 28,800. There is one curious item in our information, and that is the statement that the series machines can easily have their connections changed so as to give 150 amperes, instead of 75, thus allowing a doubling up of the station capacity. This is peculiar, unless the real facts of the case are that the machines are at present rated at about half their actual capacity, and the fields wound in two parts are now to be put in series so as to get normal high voltage with but half normal current flowing. We have above but roughly outlined this very interesting equipment for the benefit of our readers, and when the actual operation of the plant commences, we beg to assure its designers that further information will be very much appreciated. The men who have conceived and developed this system are bold men, and if their schemes are successful, will have earned for themselves reputations which will be known the whole world over; for almost every feature is different from present standard practice; precedents have been discarded, and past experience has furnished little or no basis for the solution of problems.

AN UP-TO-DATE PAPER.

Mr. J. A. G. McGregor, of 349 Beacon St., Lowell, Mass., writes : " I have gone into another line of business and will have to get other kinds of papers, so therefore I must give up those I have been taking, and I must say I do so with some regret, for I have always considered the CANADIAN ELECTRICAL NEWS an up-to-date paper in every sense of the word for the manner in which it dealt with the various questions at issue. Wishing you every success."

The operation of the gas and electric plants at Berlin, Ont., under municipal ownership, has not been satisfactory and a new commission has been appointed to undertake the management of same with a view of obtaining better results. Mr. A. L. Breithaupt has been appointed chairman.

ELECTRICAL ENGINEERING AT McGILL UNIVERSITY.

The Electrical Engineering Department of McGill University, Montreal, is located in the Macdonald Engineering Building. It is under the charge of Dr. R. B. Owens and Professor L. A. Herdt. There are also a number of demonstrators and laboratory assistants. There are probably no better equipped electrical engineering laboratories in the world, due largely to the splendid endowments of Sir William Macdonald and other benefactors.

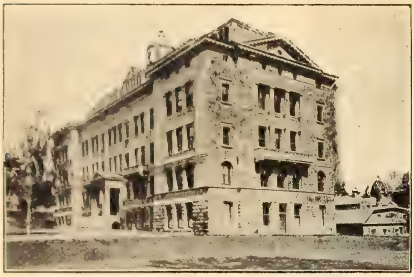


Fig. 1.—Macdonald Engineering Building.

The electrical laboatories are five in number, as follows: A direct current dynamo laboratory; an alternating current dynamo laboratory; a laboratory for special research work; a high tension laboratory, and a standardizing laboratory. In addition to this the institution has a complete service plant and battery room in the basement of the Engineering Building. These different laboratories are well shown in the accompanying illustrations.

The service plant proper consists of five boilers supplying steam to four direct-connected direct-current generators—two horizontal engines connected to two 75 k.w., 125 volt generators; one Willans engine connected to a 30 k.w., 125 volt generator and another Willans engine connected to a 50 volt 30 k.w. generator used as a booster for charging the service batteries. This battery, one of the largest in Canada, has a capacity of 300 kilowatt hours at the normal eight hour discharge In the service plant besides the generator, booster and feeder panels, there is a distributing switchboard with integrating wattmeters in each of the many power and light circuits used in the different buildings of the University.

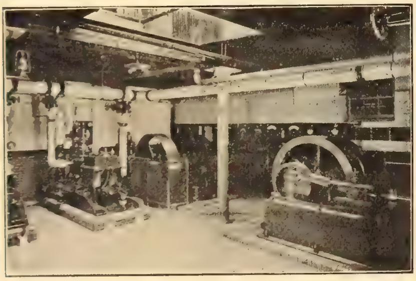


Fig. 2.—Engine Room of the Service Plant.

The Dynamo Laboratories.—One of the most notable features of the dynamo laboratories is the fact that there are no overhead belts and shafting, and that all the machinery is moveable, being easily shifted from place to place. Nothing is permanently fastened, so that any possible combination of the elements present may be made in a few moments and very simply. This is accomplished by means of a two-ton hand-travelling crane by which any machine may be picked up and moved to any place or taken out of the room altogether if desired. Before the equipment of the laboratories some six years ago, the dynamos were all driven by overhead countershafts. This arrangement was apt to cause fluctuations of speed in one machine to become evident as variations of load took place in another. The arrangement now is such that each generator is driven by a separate motor capable of independent speed control, while a sufficient number of supply circuits are wired through the laboratories to enable this to be done with the maximum of convenience. All of the machines are mounted on benches about 15 inches high. Under each of these benches is a concrete wire duct containing heavily insulated supply circuits. At intervals of five feet each of these supply circuits is tapped to insulated bayonet connections. Any generator or motor can be connected at once to any supply or other circuit

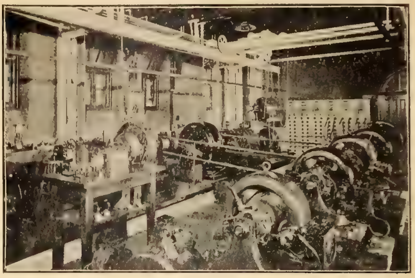


Fig. 3.—Alternating Current Dynamo Laboratory.

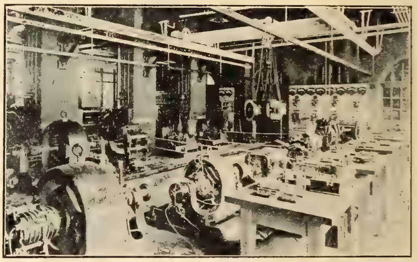


Fig. 4.—Direct Current Dynamo Laboratory.

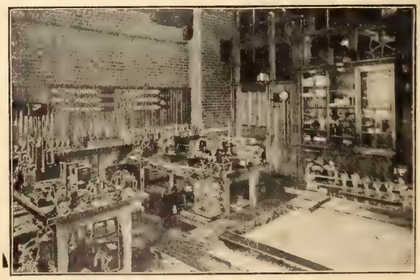


Fig. 5.—Laboratory for Special Electrical Investigations.

or connected up in any way that is desired for circulating power, tests, etc.

Besides the main supply circuits from the generating stations the laboratories are equipped with three separate sets of experimental batteries of 61 cells each, 25 amperes normal discharge rate. These can be thrown either in parallel or series on any current of the laboratories given, 110, 220, or 330 volts, besides end cell regulation as desired. The switchboard for these batteries is shown in the background of the cut of the alternating current dynamo laboratory.

A distributing board placed in the A. C. laboratory is so arranged that any source of supply that is available can be quickly and conveniently connected to any supply circuit or so that any supply circuit and transversing circuit may be connected together so as to allow practically any combination of current and machines to be made. In this department the A. C. generators are operated by individual D. C. motors, and each motor is provided with a differential winding with means of varying the number of effective turns in order to hold the speed constant over a wide variation of load.

In the system of teaching employed in the laboratory work class demonstrations are almost entirely done away with, there being at present no lectures given on the laboratory work. In the laboratories the men are divided into groups of three or four men each, and the particular work on which any group is engaged is explained to them in the laboratories by the professors and demonstrators, and the whole work is carried out under the direct supervision of the professors. To each group to whom a special piece of work in the laboratory is assigned, there is supplied a motor, a generator, and if necessary, a separate source of supply, with means of controlling and accurately measuring the speed of the motor, and means of absorbing the power generated (consisting either of wire or water rheostats), and a special portable table and leads to facilitate the work. In this way each group of students is independent and can in no way interfere with the work of another group.

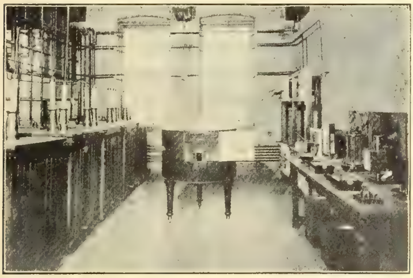


Fig. 6.—High Tension Laboratory.

The Laboratory for Special Research Work.—This laboratory is supplied with direct current of all voltages, and with alternating current of all voltages and any frequency, and is used for testing meters, transformers, small machines, fuse-wire, etc.

The High Tension Laboratory.—This laboratory has been fitted up for study of alternating currents of very high pressures. Its equipment consists of four 10 k. w. 50,000 volt transformers, and one 20 k. w. insulating transformer. It is supplied with a switchboard, a Stillwell regulator, and a Kelvin electrostatic voltmeter reading from 15,000 to 150,000 volts. To this equipment has recently been added a 10 k. w., A. C. D. C. set; a dynamostatic machine, and a 10,000-20,000 volt transformer for special research work. This equipment has recently been removed to a fire-proof concrete room which was specially built for its reception.

The Standardizing Laboratory.—This laboratory is equipped for standardizing all kinds of electrical apparatus. Its equipment includes: Weston standard voltmeter, ammeters, and wattmeter; Kelvin balances, reading among them from 0 to 600 amperes; electrostatic voltmeters; potentiometers, etc.; also a Ewings hysteresis tester and permeability bridge. In this laboratory from 200 to 300 college instruments, besides many outside instruments, are standardized every year.

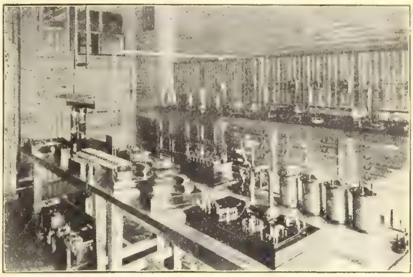


Fig. 7.—Laboratory for Standardizing Electrical Instruments.

L. A. Herdt.

MR. H. H. HENSHAW.

A familiar face at the C.E.A. convention will be Mr. H. H. Henshaw, who was recently appointed general manager of Allis-Chalmers-Bullock, Limited, Montreal. He was secretary-treasurer of the Royal Electric Company from 1886 to 1890 while they were engaged in manufacturing, and during those days he came into personal contact with electricians and engineers from all over the country. After the Royal Electric disposed of their manufacturing business he remained their secretary-treasurer until the absorption of the company in the present Montreal Light, Heat & Power Company. Since that time he has been secretary-treasurer not only of the latter, but also of its constituent companies.

Mr. H. H. Henshaw.
General Manager Allis-Chalmers-Bullock, Limited.

Mr. Henshaw was born in St. Hyacinthe in 1865 and entered the office of Mr. Walker, chief accountant of the Grand Trunk, in 1880, remaining there for the next six years. He entered upon his new duties at the beginning of June.

THE MONTREAL STREET RAILWAY COMPANY.

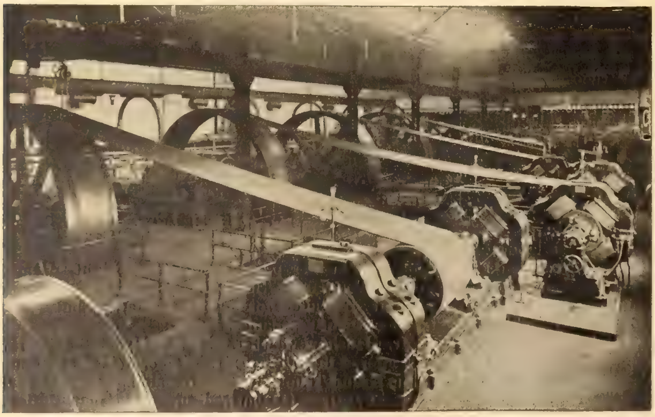
The Montreal Street Railway was converted from horse-power to electric traction in the year 1892, and since that time its growth has been very rapid. The power house of the company is situated on William and Barre streets, the frontage of the property being 394 feet and the depth 235 feet. The building is divided into four sections, two sections for boilers, one for engines and dynamos, and one for the water power plant.

One section of the boiler house contains a group of sixteen Lancashire boilers of 250 h. p. each, manufactured by Daniel Adamson & Company, Dunkinfield, England, and arranged in two batteries. Each boiler is fitted with a dead load safety valve, a six inch steam nozzle, a combined low water alarm and safety valve and a Government pop valve on the manhole. The second section of the boiler house contains a battery of six Babcock & Wilcox water tube boilers of 250 h. p. each, also a battery of six Lancashire boilers of 300 h. p. each, built by the John McDougall Caledonian Iron Works Company, of Montreal. The boilers are fed by six Northey pumps through duplicate pipes.

Exterior of Power House—Montreal Street Railway.

The section of the power house used for engines and dynamos is 235 feet long and 80 feet wide and contains six Corliss engines of 650 h. p. each, one of 3,400 h. p. , and one of 600 h. p., all compound condensing and manufactured by the Laurie Engine Company, of Montreal ; also one Corliss compound condensing engine of 1600 h. p., manufactured by the Pennsylvania Iron Works Company, Philadelphia. Each engine is provided with two governors, one of the "Porter" type capable of controlling the speed within two per cent. of the normal rate, and a governor having an automatic valve which shuts off the steam when the engine reaches 10 per cent. above the normal. The dynamos in connection with the 650 h. p. engines are belted to same, four 200 k.w. machines to each engine. The dynamos in connection with the 3,400 and 1,600 h. p. engines are direct connected and consist of one 1,500 k. w. and two 800 k. w. generators manufactured by the Canadian General Electric Company. There are also ten No. 80 Edison generators of 200 k. w. each and six multipolar generators of 300 k.w. each, manufactured by the same company. The switchboard was built by the Street Railway Company and is one of the finest on the continent. It is constructed of polished blue Vermont marble, 90 feet long and 12 feet high, and carries a complete set of instruments for the various

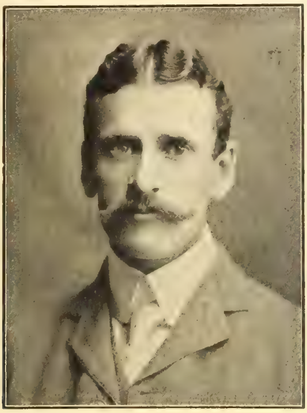
Motor Generator Sets and Switchboard—Montreal Street Railway.



Interior of Power House—Montreal Street Railway.

purposes. The feeders pass out of the building through a special tower.

The building containing what is known as the water power plant is 90 feet long and 40 feet wide and contains six direct connected motor generator sets, each having a rated capacity at the direct current end of 500 k. w. Two of these units were built by the Westinghouse Electric & Manufacturing Company and four by the Canadian General Electric Company. These machines receive current from the generating plant of the Montreal Light, Heat & Power Company at Chambly. There is also in operation in this station a 500 k. w. motor generator set consisting of a 750 h. p. induction motor direct-connected to a 500 k. w. generator, manufactured and installed by Allis-Chalmers-Bullock. This unit is used to convert the alternating current received from Shawinigan Falls into direct current for street railway purposes. The company are also establishing small power houses on St. Denis street and at St. Henri.



Mr. W. G. Ross, Managing-Director.

Mr. D. McDonald, General Manager.

The Montreal Street Railway Company at present operate abont 130 miles of track, also 40 miles of track of the Montreal Park and Island Railway Company, which they control. The rails are of the grooved girder type weighing 96 pounds to the yard and 80 pound "T" rails. The overhead construction is of the standard type, iron poles being used in many of the principal streets at an average distance of about 100 feet. The trolley wire throughout the city is No. 00, and on the suburban line is No. 0000. The feeders, of which there are about 110 miles, are No. 0000 wire, 250,000 and 500,000 C. M. insulated cables.

The rolling stock of the company consists of upwards of 800 cars, including sweepers and plows, the whole of which, with few exceptions, have been built by the company. Illustrations are shown on the following page of car No. 890, which made its first official trip last month, and which is probably the handsomest and most complete design to be found on the continent. It is of the semi-convertible type, with seats as in the ordinary steam railway coach. Instead of a five-foot platform, it has one of seven feet, and instead of the ordinary door placed in the centre there are two doors, with a brass railing dividing a portion of the platform into two aisles. One of the doors is utilized entirely by persons entering the car and the other by those leaving it. This is arranged and made arbitrary by the fact that, while one of these doors opens inward only, the other opens only outward. The conductor collects the fare when the passenger steps on the platform.

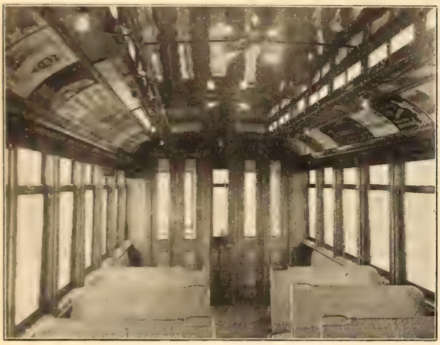
Mr. L. Trudeau, Superintendent.

Mr. H. R. Lockhart, Electrical Engineer.

The intention is that the conductor shall remain on the rear platform at all times, and, having no fares to collect from passengers in the car, can give more attention to passengers getting on and off. Another object of the new car is to prevent leakage in the collection of fares at busy hours.

The general offices of the Montreal Street Railway Company are situated in their own building, a handsome six-storey structure at the corner of Craig street and Place d'Armes. Mr. W. G. Ross is managing-director of the company ; Mr. D. McDonald, general manager ; Mr. L. Trudeau, superintendent, and Mr. H. R. Lockhart, electrical engineer. The portraits of these gentlemen are shown.

Exterior of New Car, No. 890.



Interior of New Car.

MR. FREDERICK HOFFMEISTER.

We are permitted to present the portrait of Mr. Frederick Hoffmeister, who, as announced in the May issue, has been appointed general superintendent of the British Columbia Electric Railway Company. Mr. Hoffmeister was born in Ontario, of German parentage, but some years ago removed to British Columbia, where several members of his family now reside. Giving his attention in early life to electrical matters, his ability as an electrician soon became recognized, and in 1892 he was appointed by the directors of the San Francisco and San Mateo Railway Company as chief electrician and superintendent of the power department. Three years later he was appointed a member of the Faculty of the Van Der Nailleus School of Practical, Civil, Electrical, Mechanical and Mining Engineering, San Francisco, Cal., as Professor of Electrical Science as applied to electric railways and steam engineering. For the past eight years he has been employed by the Canadian General Electric Company as erecting engineer, and during that time has superintended the installation of some of the most important plants in Canada.

Mr. Hoffmeister was resident engineer for the installation of the electric plant for the operation of the Soulanges canal, this work requiring about four years. This is one of the finest canals in the world and the electrical equipment is second to none. It was one of the first canals to be operated by induction motors. During the winter seasons, when the work on the Soulanges installation was suspended, Mr. Hoffmeister installed the complete electrical apparatus in the power house of the Canadian Electric Light Company at Levis, Que., also the first synchronous motor generator set used by the Montreal Street Railway. Later he remodelled the Halifax Electric Tramway Company's plant, changing it to the new system, with three-phase apparatus exclusively and running motor generator sets for the railway. He also remodelled the St. John Railway Company's power house and installed a new marble panel switchboard. The alternating current three-phase system was here adopted also, although direct current generators are employed for street railway work. He then installed a three-phase alternating current water power plant for the Renfrew Power Company and for the past year has been employed in Winnipeg in connection with the Winnipeg Street Railway Company's plant and the electrical equipment of the new C.P.R. shops. Two 600 k.w. C.G.E. generators in the C.P.R. shops have been started up during the past month.

Mr. Hoffmeister has had a thorough practical experience and will doubtless be found a valuable acquisition by the British Columbia Electric Railway Company. He is unassuming but affable, and carries with him to his new field of labor the best wishes of a host of friends.

Mr. Frederick Hoffmeister,
General Superintendent British Columbia Electric Railway Company.

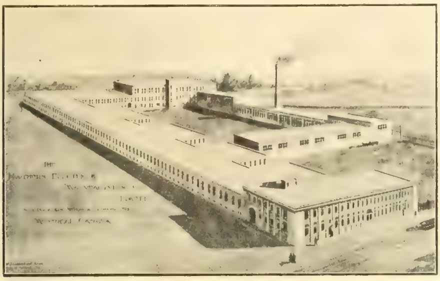
The time for receiving tenders for the purchase of the street railway at Kingston, Ont., expired on June 1st, but no bids were submitted. Mr. J. M. Campbell will, it is understood, report on the question of whether the railway can be operated at a profit under revised conditions.

We understand that the Electric Repair & Contracting Company, 917 and 619 Lagauchetiere street, Montreal, have been appointed, by Messrs. Read & Kilmer, of Toronto, the Montreal agents of the General Electric Company of Sweden, manufacturers of every description of electrical apparatus.

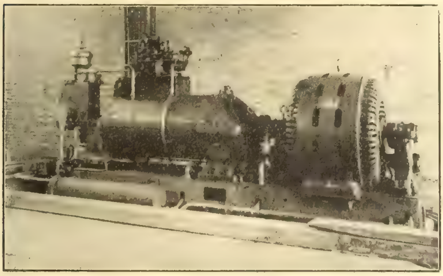
POWER PLANT OF THE NORTHERN ELECTRIC & MANUFACTURING COMPANY.

The Northern Electric & Manufacturing Company have an interesting power plant at what is known as their cabinet shop at corner of William and Richmond streets, Montreal, the equipment including a Westinghouse-Parsons turbine.

The power plant is practically isolated from the rest of the buildings and consists of a one-storey practically fire-proof building. The boiler equipment consists at present of two 250 h. p. Babcock & Wilcox boilers, supplied with "Jones" underfeed stoker. The feed water will be obtained from the canal, and it is proposed to install a 100,000 gallon tank in the yard, which will supply both the boiler feed water and the water neceseary for the sprinklers and fire protection, as well as manufacturing purposes.


Factory of Northern Electric & Manufacturing Company, Montreal.

The engine room is located directly alongside of the boiler house ; the equipment consists of a 300 k. w. Westinghouse-Parsons steam turbine direct connected to a Westinghouse 3-phase, 60 cycle, 220 volt turbo-generator, which will supply the current for the motors and lights. It is proposed for the present, owing to the light load which the generator will carry, to operate the turbine non-condensing, the exhaust being carried into a Webster heating system, with which the building is installed. The exciting current for the generator is obtained from a 10 k. w. Westinghouse generator direct connected to a Westinghouse junior engine.


Westinghouse-Turbo-Generator in Northern Electric & Manufacturing Company's Plant, Montreal.

The switchboard is so arranged that each feeder circuit has its own ammeter panel, and as most of the motors are large, it has been found possible to allow a separate panel for each motor.

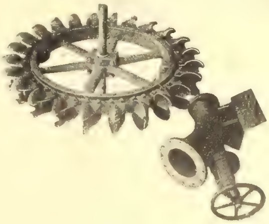
The wiring to the motors is carried through a trench 8 feet by x 4 feet, which runs along the west wall of the building and terminates in the cabinet shop, where the circuits are distributed to the various floors in the building. With the exception of the elevator motor, which is a Westinghouse Type "F" variable speed induction machine, the motors for driving the machinery are of the Westinghouse constant speed induction type, and are also suspended from the ceiling with a view to allowing the greatest amount of floor space to be utilized.

The motor equipment at present consists of one 75 h. p. and one 40 h. p. equipped with double crown pulleys at each end so that each motor drives four lines of shafting, and one 40 h. p. which operates the saw-dust of the exhaust system. The line shafting throughout the cabinet shop is supplied with Chapman ball bearings.

The saw-dust exhaust system is now being installed, which will carry the saw-dust to the boiler house, and it is expected to be able to obtain sufficient fuel to supply one boiler.

THE DOBLE WATER WHEEL.

Modern hydro-electric power generation and transmission has led to great improvements in water wheels. A demand has arisen for large units of highest economy, close regulation and absolute reliability in service, and Tangential water wheels to operate under high heads of water have to a large extent been developed to meet this demand.


Doble Wheel with Needle Regulating Nozzle.

The Abner Doble Company have made a specialty of producing first class machinery to meet the requirements of the most exacting conditions. All wheels are provided with their well known patented ellipsoidal buckets. These buckets are castings of selected and tested materials ; cast iron, semi-steel, gun metal, or steel castings as may be required. Each bucket straddles the wheel rim and is machined to fit tightly on both sides and on the periphery. Each is fastened to the rim by two fitted bolts in reamed holes.

The buckets are interchangeable, being accurately fitted and drilled in jigs, and finally brought to the same weight so that the wheels shall be dynamically balanced.

The Doble patented needle regulating nozzle has the advantage of permitting close regulation, maintaining a high efficiency of the jet over a wide range. The regulating is done by moving a core piece axially within the nozzle, and thereby changing the annular area of the orifice.

As announced in a previous issue, the John McDougall Caladonian Iron Works Company, of Montreal, have been appointed sole Canadian licensees for the manufacture of these wheels in Canada.

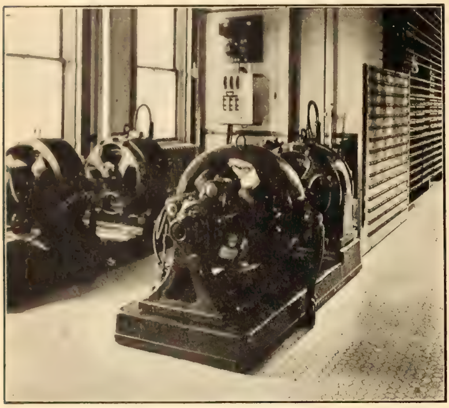
Mr. G. S. Perry, representing the Pacific Coast Pipe Company, Vancouver, B. C., has submitted to the ratepayers of Ponoka, N. W. T., a scheme for the installation of waterworks and electric light systems.

Dr. C. G. Main, Mayor of Edmundston, N. B., announces that that town is to have a lighting plant, and that he has taken up the question of the design and installation with Mr. R. S. Kelsch, consulting engineer, Montreal.

NEW EXCHANGES OF THE BELL TELEPHONE COMPANY, MONTREAL

To provide for their rapidly increasing business in Montreal, the Bell Telephone Company have found it necessary to build a new main exchange adjoining the old one. This is now nearing completion, and has installed in it a very complete power plant, which was designed by Mr. E. G. M. Cape, C.E.

Power is supplied by two 50 k.w and one 17½ k. w. machines. The latter machine will be started in the evening about seven or eight o'clock, after the heavy lighting load is over, and will run until nine or nine thirty in the morning, when the charging of the batteries for the telephone exchanges will be commenced. This charging current will bring the total load up to about 50 k.w., and one of the large units will be started to carry it. This machine will be run throughout the day, carrying the heavy lighting load in the afternoon. It is probable that in operation the charging will take place somewhat later in the day to bring the two peaks of the loads, namely, that due to charging and that due to lighting, closer together, and so decrease the time of running of the larger unit.



Power Plant, "East" Exchange, Bell Telephone Company, Montreal.

In the design of this plant one point that had to be kept in mind was that continuous operation was essential on account of the telephone exchange, as it would be impossible to shut it down for even five minutes. To eliminate the possibilities of an interruption in the service, several precautions were taken. There are three boilers, any two of which can do the work; two k. w. and one 17½ k. w. machines, any two of which can handle the maximum load. There is a ring system of steam piping, with the valves so arranged that should a break occur at any point whatsoever in the steam pipe, it would still be possible to run two boilers and two engines in any case. As a further precaution, the switchboard is arranged with two sets of bus bars, one to be connected to bear outside sources of power, thus rendering the possibility of a shut-down almost out of the question.

The mechanical plant may be divided up into that belonging to the old building and that belonging to the new. In the old plant there are two Babcock & Wilcox boilers, having a heating surface of 1,265 sq. ft. each. The new boiler is of the same size.

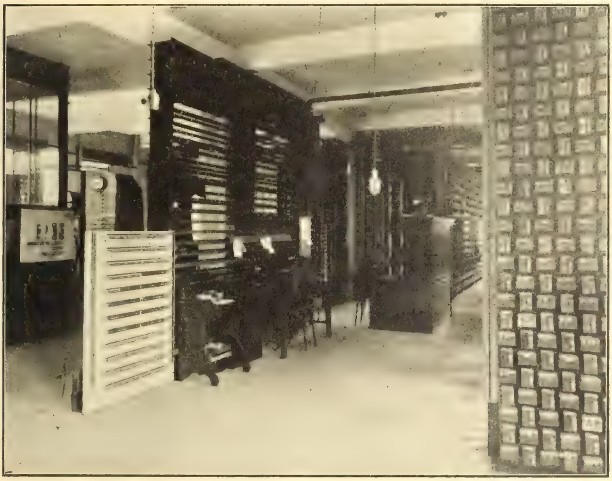
The machinery in the new power plant proper consists of the three generators mentioned before, installed by the Canadian Westinghouse Company, direct connected to Robb-Armstrong engines. The generators are of the engine type, 125 volt direct current. The two 50 k. w. units run at 275 revolutions per minute. These machines are direct connected to 12x12 in. simple horizontal engines. The 17½ k. w. generator runs at 375 revolutions per minute, and is directly connected to an 8x8 in. engine. The engines are designed for a working pressure of eighty pounds, but allowance has been made to increase the pressure to 125 pounds if it is found desirable. The generators are connected to the switchboard by leads running in conduits under the floor.

The switchboard consists of three generator and two feeder panels, so arranged that an extra generator or feeder panel can be added without disturbing the others. An unusual feature of this switchboard is that it is provided with a double set of bus bars and double-throw switches to the various circuits. One of these sets of bus bars is connected to the machines through three-pole switches. The other set of bus bars may be connected to another source of power by means of the large 800 ampere switch. The board is so arranged that current may be either given to or received from the outside circuit.

Under ordinary circumstances the gases from the boilers are taken away through a 4-ft. stack. There is also an induced draught fan capable of handling the gases from the three boilers and of maintaining a draught in the main breaching equal to a water pressure of 1¾ inches. The fan has a blast wheel 60 in. in diameter and is driven by a 6 in. vertical engine. This fan is placed on by a by-pass so that the gases from the boiler can go directly to the chimney or through the fan. To avoid any possibility of the feed water supply being shut off from the boilers the pipes are arranged in the loop system as in the case of the steam pipes. From the pumps the water passes through an oil filter that extracts all the oil before it is received into the feed water heater. It will be seen from the foregoing that this plant was designed with a view to continuous service, and from the manner in which the installation has been effected, there seems little possibility of any interruption occurring.

Section of Subscribers' Switchboard, "East" Exchange, Bell Telephone Company, Montreal.

A test of the plant was made recently, the duration of which was nine hours. The coal used was pea anthracite. There were two boilers under steam, the first furnishing steam for the heating of the building and for the auxiliary plant, consisting of elevators, feed pumps and the ventilating fans. The second furnished steam to the 50 k.w. unit and to the 17½ k.w. unit. It was found that the coal consumption per hour in boiler No. 1 was 200 pounds and in boiler No. 2 472 pounds, and the water evaporated per pound of coal by meter 8.26 lbs. The average steam pressure was 79 lbs. per square inch, and the average kilowatts of the two units was 58.8. The steam per k.w. hour was 66.3 lbs. and per I.H.P. per hour 36.4 lbs. The coal per k.w. hour was 8.03 lbs. and per I.H.P. was 4.41 lbs. The compound efficiency of the 17½ k.w. unit, that is, the electrical horse power, divided by the indicated horse power, was 67.5 per cent., and the compound efficiency of the larger unit was 75.6 per cent.



Part of Rack Room, Fuse Panel and Wire Chief's Desk, "East" Exchange, Bell Telephone Company, Montreal.

NEW "EAST" OFFICE OF THE BELL TELEPHONE COMPANY.

The Bell Telephone Company have recently completed the installation of an entirely new central office equipment for their East Exchange in Montreal, which has many interesting features. The building was erected by the company on St. Andre street, immediately south of St. Catherine street, and is used entirely for telephone purposes. It is a handsome three storey and basement structure of fire-proof construction throughout, 40 ft. 6 in. x 126 ft. 6 in. The front is of grey pressed brick, the upper stories laid in Flemish bond, the ground floor laid with Roman brick, all with Ohio facings and trimmings. All the windows in the sides and rear have metal frames with wire glass, and in addition are protected with exterior dry sprinklers, the combination giving the best possible protection against an exterior fire. There are two stairways, one at the front, the other at the rear of the building, each completely enclosed in a fire-proof brick tower, the openings on each floor being equipped with underwriters automatic fire doors by means of which the stairs can be absolutely cut off from the building proper or adjacent building, thus forming fire-proof fire escapes. The woodwork of the building is of quartered oak ; the front halls have marble wainscott and mosaic floors, while the rear stairs are plain iron, and the tower is lined with buff pressed brick.

At the left of the entrance on the ground floor is the public telephone room in charge of an attendant, fitted with sound-proof booths and furnished for the comfort and convenience of the patrons. The entire rear of this floor will be devoted to a training school for operators, with lecture rooms and sections of regular switchboards at which the operators will be trained for four weeks before occupying positions on the subscribers' board. The front of the first floor is devoted to the distributing and power apparatus used with the switchboard, while the rear is given up to operators' quarters. The wires enter the building in paper insulated lead covered cables, each one containing 400 pairs of No. 22 B & S wire which are drawn into ducts built in the wall. The pairs are terminated on the Main distributing frame by means of cables, the ends of which are non-hydroscopic. On the vertical side are placed heat coil and carbon protectors of the well-known standard pattern. The lines next run through switchboard cable to an intermediate distributing frame, by means of which the lamp signals of the various subscribers' lines can be changed from one operator's position to another without change of line number, and the traffic or calls handled at the various positions balanced and the work equalized. Power for the operation of the exchange is obtained from eleven cells of type G 41 chloride accumulators having a capacity of 3200 ampere hours. These cells are charged by means of a special 30 k. w. generator having a large number of commutator segments to reduce the noise in the associated telephone circuits when charging, direct connected to an induction motor which is run from the street circuit. A duplicate motor-generator is provided as well as a second power supply circuit to guard against breakdowns. On this floor are the repeating coils used in the switchboard cord circuits and the wire chief's desk, equipped with voltmeters, relays, keys, etc., for the locating of faults.

To the rear of the power room and approached by the rear stair are the rooms for the accommodation of the operators, consisting of a locker room, lavatory aud bathroom, together with a large sitting room furnished with chairs, lounges, tables, etc., and fitted with a heater for tea, which is in charge of an attendant and from whom operators may obtain tea at any time when off duty. In the locker room is a clothes drying apparatus, by means of which wet wraps may be dried before being placed in the lockers, which are made of expanded metal and are large enough to accommodate the belongings of two girls.

The third floor is devoted entirely to the switchboard and is one of the best operating rooms in the country. The switch is divided into two parts, the subscribers', or, as it is technically known, the "A" board, being on the north side of the room, and the trunk or "B" board on the south. At the "A" board terminate the lines of all subscribers in the exchange, of which there are about 3,500. The switch has a capacity of 10,000 lines and is at present equipped for 5,600, divided among 54 operators' positions. The system is of the well-known common battery or relay type, by means of which when a subscriber removes the telephone from the switch hook of his set of instruments a small incandescent lamp is lighted at the switchboard. The operator plugs one of a pair of cords into the answering jack of the line which is immediately above the line lamp and asks for the number ; the second cord is plugged into the number given in the upper or multiple part of the switch and the subscriber rung. Associated with the two cords are two lamps similar to the line lamps ; when a cord is connected to a line and the telephone ot the set is on the hook the lamp is lit, as soon as the telephone is removed the lamp goes out, consequently the operator is able to tell at a glance whether or not the called subscriber has answered, or if the conversation is completed, in which case both lamps burn and she takes down the connection. By this system faster and more accurate operating is obtained and the subscriber is spared the annoyance of inquiries such as "Have they answered?", "Waiting?", "Finished?", and the like. In a similar manner, if the call is for a subscriber in one of the other three city exchanges the second cord is plugged on to a "trunk line", a number of which are run between the four offices, which is assigned to the line operator by a trunk or "B" operator at the distant office, who is called over on an order wire connected to her head telephone.

The "B" operators in the East office are seated before a board on the south side of the room. There are no annunciators on this board, the trunk lines terminating in cords and plugs. Upon an operator receiving a call over an order wire, she inserts one of the plugs into the line called for, at the same time telling the distant "A" operator the number of the trunk cord used; she then depresses a ringing key and the "A" operator at the first office inserts the second of the pair of cords she is using into the jack of the trunk line assigned to her. As soon as she does this, and not before, ringing current is sent out to the subscriber called through the ringing key; this current is sent out for one second at four second intervals automatically, so the subscriber is rung once every four seconds until he answers. When his telephone is lifted from the hook, the ringing key flies back to its normal position, the ringing current is discontinued and conversation may be carried on. Each trunk cord has associated with it a disconnect lamp which glows when the "A" operator removes a plug from the trunk jack, thus giving the "B" operator a positive signal to disconnect also; by this means the trunk lines are cleared rapidly, a point of the utmost importance. Fourteen of these "B" positions are provided, each equipped for thirty trunk lines. In addition to the two switchboards are two desks for the chief operator and her assistants, also a six position information table for the clerks who answer enquiries as to numbers which have been changed or not in the telephone directory, etc.

The switchboard was manufactured by the Northern Electric and Manufacturing Company of Montreal and represents the best and most modern telephone practice. All the wires and cable used in its construction were furnished by the Wire & Cable Company, also of Montreal.

A new building will shortly be erected for the uptown office, in which will be placed a plant very similar to the one described, when the whole of the Montreal Exchange will be on a common battery basis.

THE SAYER ELECTRIC COMPANY.

Mr. Ernest W. Sayer, the present proprietor of the Sayer Electric Company, Montreal, started in the electrical business in the early part of 1890, with T. W. Ness, as messenger boy, later serving in the office and as stockkeeper, and then entering the wiring department. In 1894 he tendered his resignation to accept a position with the Montreal Electric Company, with whom he remained until May, 1896. He then started in business on his own account, at 60 Victoria square, in a very small way. He continued in business under the style of E. W. Sayer till 1899, when he accepted a partner and changed the name to Dockrill & Sayer, carrying on business as electrical contractors, plumbers, steamfitters, etc. This partnership was not a successful departure for Mr. Sayer, resulting in a total loss of all money invested by him. He started again at the old stand in July, 1900, under the firm name of the Sayer Electric Company, and since then he has gradually advanced until now the firm is recognized as one of the largest electrical contractors in Montreal as well as an important factor in the wholesale trade, this branch of the business increasing some $20,000 the last year. They have completed some of the choicest contracts in Montreal and are reported to be one of the best electrical advertising firms in the Dominion. They have some of the cream in the electrical agencies for Canada in mostly all lines.

Mr. Ernest W. Sayer.

Mr. Sayer is now forming a $100,000 limited company to go extensively into the manufacture of electrical specialties and supplies and as general electrical contractors for all classes of work. He should have no difficulty in raising the necessary capital to float the enterprise. There will be a limited amount of preferred stock issued, the balance to be common, at $100 per share.

The present headquarters of the Sayer Electric Company are at 10, 12 and 14 Beaver Hall Hill, Montreal.

A VISIT TO NIAGARA FALLS.

By courtesy of the Electrical Development Company, the Canadian Niagara Power Company, and the Ontario Power Company, members and friends of the Toronto Branch of the American Institute of Electrical Engineers numbering 46, had the pleasure on June 1st of inspecting the works in process of construction at Niagara Falls for the development of electric power, and were tendered a luncheon at the Dufferin Cafe. The following persons participated :—

T. R. Rosebrugh, G. W. Blaikie, R. G. Black, R. H. Zavitz, Edw. B. Merrill, Wm. A. Bucke, H. G. Arnott, M. J. Overall, H. W. Price, W. B. Allan, J. Sangster, R. R. Wiley, W. K. Wiley, W. S. Hough, Arthur K. Spotton, F. H. Foster, Wm. C. Brown, C. L. Fellowes, W. A. Fiske, S. W. Bradley, Geo. C. Rough, E. J. Lockie, V. Boyd, A. Cecil Knight, B. C. Ansley, E. B. Walker, A. A. Walker, H. C. Walker, R. A. Sara, H. F. Hutcheson, D. M. Johnston, F. S. Keith, A. E. Forman, John Curtis, C. H. Wright, P. E. Hart, F. Hoffmeister, John Watts, W. G. Angus, J. J. Wright, A. B. Smith, C. H. Mortimer, R. T. MacKeen, A. H. VanCleve, Julian Thornley, H. W. Bucke.

MEMBERS OF TORONTO BRANCH A.I.E.E. AND FRIENDS, NIAGARA FALLS, JUNE 1ST., 1905.

The party embarked at Toronto for Queenston at 7.30 a.m., and from Queenston proceeded to the Falls by electric railway. The weather proved very favorable for the visit.

As our readers are aware, there are three propositions under-way by the above named companies for the development of electric power at Niagara Falls, involving a total expenditure of about $15,000,000. Niagara Falls at the present time is consequently the most interesting spot in the world for the electrical engineer, exhibiting side by side with one of the greatest natural powers in the world wonderful evidence of engineering skill.

As full descriptions have already been published of these power development works, it is not the purpose to enter into minute details regarding them. The works of the Canadian Niagara Power Company and the Electrical Development Company are, to a large extent, patterned after those of the Cataract Power Company established on the American side some ten years ago. It is a testimony to the ability of the original designers of these works, that, after a decade has passed away, little improvement can be made on them. In the case of these companies the power house is placed close to the intake, the necessary head being obtained by placing water wheels at the bottom of a wheelpit 150 feet deep, and transmitting the power there developed to the machinery above by means of vertical shafts. It is understood that the new works will be less expensive in construction than those on the American side.

The Canadian Niagara Power Company have completed an equipment having a capacity of 50,000 horse power, and are now engaged in the extension of their wheelpit, the construction of another building, and the installation of additional plant which will double their output.

The Electrical Development Company have planned for the development of 125,000 horse power, and, like the other companies, are vigorously pushing the work forward to completion, about 200 men being employed in the tunnel which is being constructed beneath the Niagara river from the power house to the brink of the Falls. The purpose of this tunnel is to discharge the water which has passed through the water wheels. For this purpose the Canadian Niagara Power Company have constructed a tunnel along the shore, having its outlet into the Niagara river below the Falls.

The outer walls of the Electrical Development Company's forebay will be submerged, to allow ice which may form to float away over the top of it. During last winter a part of the Canadian Niagara Power Company's intake was destroyed, by the expansion of ice in the forebay.

Pending the completion of their works, the Electrical Development Company have arranged for a supply of current from the Canadian Niagara Power Company's works for transmission to Toronto.

The Ontario Power Company have adopted a different method by placing their power house immediately below the Falls, and only sufficently above the level of the river to insure the safety of the building and contents against rising water. Their intake is above that of the other two companies. The water is diverted from the river into a basin from which it will be conducted to the power house, a distance of nearly two miles, by three steel conduits each 18 feet in diameter. The first of these conduits has just been completed. The water from this conduit will be sufficient to operate the machinery now being installed in the power house. The capacity of each conduit is about 66,000 horse power.

The plant now being installed consists of six Westinghouse generators each having a capacity of 11,000 horse power. Each of these units, with two water wheels, operate on a shaft weighing 66 tons, the generators being placed on one end of the shaft, and being balanced by the water wheels on the other. These wheels are of German manufacture, experience having demonstrated that they are better adapted than any other for operation under high heads. It is expected that one of the generators will go into operation on the 1st of July. The water wheel controllers and exciters are arranged in a gallery along one side of the station, while the switchboards and other controlling apparatus have been installed in a substantial brick transformer house near by. The power house itself is constructed entirely of concrete and is fireproof. The company were fortunate enough to get the building roofed in before the winter came on, and were thus able to proceed without interruption with the installation of the machinery. They are understood to have made a contract to transmit some 50,000 horse power to the city of Rochester.

The greatest care is being exercised by all the companies to prevent the possibility of interruption to the service.

The visiting party were under the conductorship of Mr. R. T. McKeen, Secretary of the Toronto Branch of the American Institute of American Engineers, and were received and given every possible attention by the resident engineers of the different companies. A reproduction is here given of a group photograph taken, following the luncheon, by Mr. C. H. Wright, on the lawn in front of the Dufferin Cafe.

THE ALLIS-CHALMERS-BULLOCK WORKS.

The works of Allis Chalmers-Bullock, Limited, which should be visited by delegates to the convention, are situated on the Lachine Canal, just outside of the city limits of Montreal, and having sidings both from the Grand Trunk and Canadian Pacific Railways are well provided with transportation facilities. There are five main buildings, viz., machine shop, blacksmith's shop, pattern shop, foundry and power and testing building. They are all of the most modern type, being brick enclosed, structural steel buildings on stone and cement foundations and having stone and cement piers. A narrow gauge industrial railway runs through the buildings and from one to the other, supplementing the cranes and reducing the labor of transportation.

The main machine shop, of which an interior view is given, is 400 ft. long by 100 ft. wide and 35 ft. high. A 20-ton travelling crane, with a span of 42 ft., is shown at the far end of the building. The general arrangement is of the most improved design and affords ample light for all operations. The centre aisle is devoted to assembling some of the heavier machinery, while at the sides are installed all other machines. The power is derived from a 300 h.p. Goldie & McCulloch "Ideal" high speed engine direct connected to a 200 k.w., 250 volt, direct current Bullock generator. A recent addition to the equipment is a 12 ft. Niles self-driven boring mill, operated by a Bullock multiple voltage system of control. In addition to this there are over 100 machine tools, embodying the latest designs in duplex and horizontal boring machines, double headed planers, slotting machines, universal milling machinery, drill grinders, radial and power drills, boring and turning mills, threading machines and a large number of lathes. A Newton portable vertical milling machine is now being erected on a cast iron floor plate about the centre of the shop.

MAIN MACHINE SHOP, ALLIS-CHALMERS-BULLOCK WORKS.

The power and testing building is 300 ft. long by 60 ft. wide, with brick enclosed cement flooring. It is divided into three parts, separated by fire walls and metal doors, one for the boilers, one for the power house, and the other for the electrical department. An interior view of the latter is given, taken from the top of the annealing oven at one end. At the other end is shown a 750 h.p. motor generator set for the Montreal Street Railway. About the centre of the building is shown the 20-ton electric travelling crane, and in the foreground are shown the motor driven punching and shearing machines. The annealing oven, from which the view is taken, is built against the wall separating this department from the power house. It has three grates and the oven gates are lifted by pneumatic power. The carriage upon which the metal to be annealed is placed, rolls on ten inch balls set in tracks. A notable feature in connection with the oven is an electric pyrometer which enables the temperature to be read at a considerable distance. This pyrometer is the invention of Dr. Barnes and Dr. Tory, of the science faculty of McGill University, and measures the heat of the oven within five degrees in eight hundred. There is also an oven for dipping the coils in special insulating varnish and for baking them. This process is a special feature in the treatment of the windings of Allis-Chalmers-Bullock electrical machinery. The electrical engineering is in charge of Mr. H. A. Burson, M. Sc., who has made a specialty of induction motor design.

The blacksmith shop is 100 ft. by 80 ft. by 30 ft. high, with iron clad, wood enclosed composition roof. It is equipped with forges, Bertram steam power hammers, Sturtevant fan motor, two 3-ton jib cranes with 15 ft. swing, travelling on single tracks.

The pattern shop adjoining the smithy is 170 ft. × 60 ft. and 20 ft. high, with wood flooring. The power is derived from a direct current motor. It is fitted with band saws, pattern maker's lathes, buzz planers, rip and cross-cut saw tables, etc. The building is divided by a brick partition from the pattern store-room.

The foundry is 200 ft. by 100 ft. and 35 ft. high. It is of the same construction as the other buildings with a frame addition for storing castings. A 20-ton electric travelling crane facilitates casting operations and a 5-ft. auxiliary crane is also used. The cupola is a No. 9 Whiting Foundry Company, connected with a No. 8 Sturtevant fan, run by a 33 h.p. motor. A pneumatic elevator carries the cupola charge to the upper platform. About ten tons of metal are used in the daily cast. For the larger castings, such as frames of generators, etc., two large floor pits have been prepared, one 18 by 14 ft. and 3 ft. deep, and the other slightly smaller.

To comply with the Underwriters' rules for fire protection, an 18 × 10 fire pump is provided. Set up in the power room is a complete Sturtevant heating system, consisting of two 170" housing fans direct connected to 10 × 12 horizontal engines and two 11 section heaters with 80 9-ft. pipes in each section.

In the boiler room are two return tubular boilers of 100 h.p. and a Babcock & Wilcox 200 h.p., together with a 200 h.p. Laurie heater. These supply heat for all the buildings, as well as the steam for power.

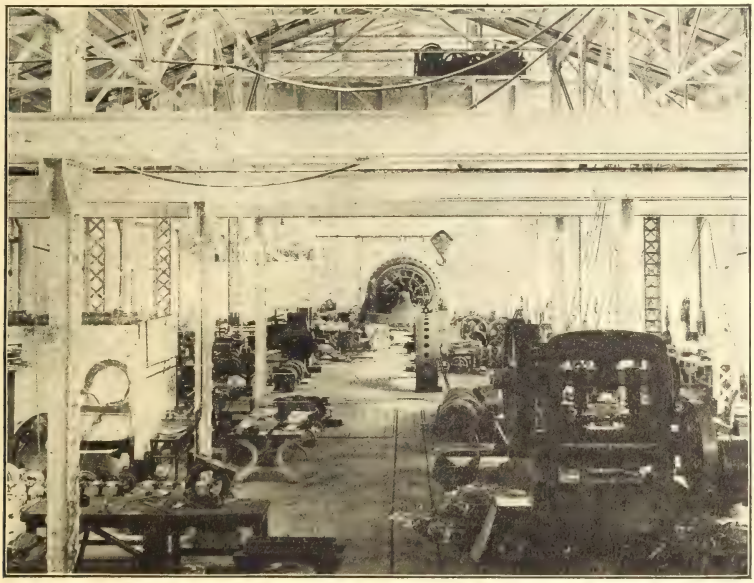
The scope of the company is very broad, for it has secured the rights to manufacture in Canada machinery of the Allis-Chalmers Company, Milwaukee ; Bullock Electric Manufacturing Company, Cincinnati ; the Ingersoll-Sergeant Drill Company, New York, and the Lidgerwood Manufacturing Company, New York.

The electrical apparatus manufactured by the company includes the following :

Alternating current—Belted, engine, fly-wheel and water-wheel types of generators ; induction and synchronous motors, rotary converters, transformers.

Direct current—Bullock teaser equipments for printing presses, multiple voltage balancing sets, small bipolar and multipolar motors and generators, street car equipments.

Mr. H. H. Henshaw, formerly secretary-treasurer of the Montreal Light, Heat & Power Company, is the general manager of Allis-Chalmers-Bullock, Limited.



Electrical Department, Allis-Chalmers-Bullock Works.

GROUNDS IN ALTERNATORS.

By L. O'Connor.

Locating faults in alternators is a comparatively easy matter for the expert, with his expensive instruments and apparatus, but it is not so simple a problem for the engineer of the small central station, who has probably nothing in the way of instruments except the ordinary station voltmeter and a magneto testing bell. With the bell, of course, he can ascertain whether a grounded coil really exists, but it is another proposition to locate the particular coil in which the fault lies.

A simple method of locating a ground in a single phase alternator armature, which has been utilized by the writer, is given below. This method may also be used, of course, for two phase machines.

To proceed, first run the machine up to speed with main switch open and fields properly excited ; then adjust rheostat until the voltage is normal. Now disconnect the primary leads of the voltmeter transformer and connect them one to the frame of the machine and the other to one of the armature terminals. The easiest way to do this if the armature is of the revolving type is to make a temporary connection to one of the brushes. If a ground really exists the voltmeter will now indicate a certain E. M. F. which will depend on the number of armature coils between the armature terminal and the grounded coil. This reading is noted and the transformer lead is then changed over to the other brush, and again the voltmeter reading taken. The sum of these two readings should equal the normal voltage if the ground is a good one.

For instance, we will suppose the normal voltage is 110, and that the pressure, as found above, between the first brush and the frame is 90 volts, and that the pressure between the second brush and the frame is 50 volts, and we will also assume that there are 16 coils in the armature. Then, $110 : 16 :: 60 \quad x = 8\,{}^{8}/_{11}$ coils between the first brush and the ground. The trouble in this case would evidently be in the ninth coil and close to where it is connected to the tenth coil. To avoid the consequences of any errors in the readings taken, remove the connection between these two coils, thus dividing the winding into two parts. By now testing each part separately with the magneto, will determine whether the ground is in the ninth or tenth coil.

If the sum of the two readings does not equal the normal voltage it indicates that the ground has a certain amount or resistance. In this case subtract the sum of the readings from the normal voltage and add one-half of the difference to each of them. This will give the corrected readings.

An alternator will operate normally with a single ground. Let a second ground occur, however, and trouble ensues ; or the attendant may accidentally touch frame and brush at the same time and receive a bad shock. For these reasons machines should be tested daily, and if found grounded, should be repaired as soon as possible.

AN INVITATION.

All friends and delegates to the Montreal convention are cordially invited to call at the Eastern office of the Packard Electric Company, Limited, Room 42 Street Railway Building, where Mr. Geo. C. Rough, Manager Sales Department, and Mr. J. Warren, Acting Manager Eastern office, will be pleased to discuss the merits of the well-known Packard specialties, incandescent lamps, meters and transformers, as well as Jandus arc lamps and Crocker-Wheeler apparatus.

Mr. Frank P. Miller, of Buffalo, has been given the contract of installing an electric plant for lighting the grove at Fort Erie, Ont.

Mr. J. G. Harvey, Chairman Fire, Water and Light Committee, Dauphin, Manitoba, makes the statement that the Town of Dauphin is to have an up to date lighting plant, and that they are in communication with Mr. R. S. Kelsch, consulting engineer, Montreal, with a view of obtaining his services as consulting engineer, to design and construct the plant.

EUREKA AUTOMATIC SWITCH.

For many years the want has been felt of some device which will protect the public using electricity from the dangers consequent upon the accidental raising of the harmless low voltage of the service wires in their houses to the deadly voltage of the transmission wires on the street.

Such accidents may occur and have occurred in various manners, of which the following are the more common:

(1) The breaking down of the insulation of transformers.

(2) The breaking of high voltage wires and the consequent failing of same on lower voltage.

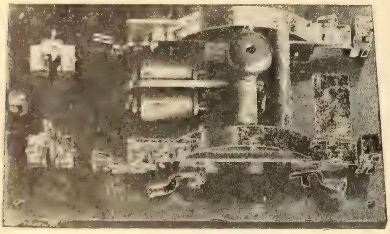
(3) The breaking of telephone, telegraph, fire alarm wires and the dropping of these across high and low voltage wires.

All of these accidents are almost of daily occurrence in some part of the country, and statistics show that an average of 152 persons a year, or about three a week, are killed through such accidents in the United States and Canada. Moreover, 90 per cent. of the electrical fires are caused in this manner.

There have been several devices on the market to obviate this danger. Hitherto none have been a success, either because they were too expensive in their design and construction, or because they were condemned by the insurance people as not being capable of doing the work proposed in a safe and efficient manner.

The "Eureka" automatic safety switch is claimed to be the only device which has obtained the unqualified approval of the Board of Fire Underwriters. It is absolutely certain to work should the danger threaten and it is equally certain not to work, causing trouble and inconvenience, unless such danger is present.

Its manner of operating is as follows: Should a high voltage circuit of any description become connected to the wires entering a house in which this switch is installed, or should an inductive lightning discharge enter the wires, the switch will open in one fiftieth of a second, cutting off all connection and preventing any danger. It is then necessary to call up either a competent electrician or the Light and Power Company and have the matter investigated before closing it again.



EUREKA AUTOMATIC SWITCH.

Should the opening of the switch be caused by an inductive lightning discharge, the switch can be safely closed at once and will remain closed. Should a high voltage circuit cause it to open, the switch should be left open until such dangerous connection has been removed. An attempt to close it might be dangerous, for although it will not remain closed, the momentary connection made by such an attempt may be sufficient to set fire to the building, or to kill an inmate attempting to turn on a light. After the trouble is removed, the switch may be closed and is ready for operation again should the accident be repeated.

The "Eureka" automatic safety switch is manufactured by the Sayer Electric Company, Montreal.

THE KAKABEKA FALLS DEVELOPMENT.

Mr. R. S. Kelsch, Chief Engineer of the Kakabeka Power Company, advises us that the action of the Private Bills Committee of the Ontario Legislature, in putting off the settlement of the Kakabeka Falls dispute till next session, will not in any way interfere with the construction work of the Kakabeka Power Company. Mr. R. W. Leonard has been engaged as resident engineer, and is now on the ground supervising the construction of living quarters for the large force of men who will soon be engaged on all parts of the work. A large plant, consisting of dredges, railway engines, dump cars, derricks, concrete mixers, etc., has been shipped to Fort William. Mr. Leonard is well known to the engineering profession, and has the reputation of being a hustler. He has had charge of the construction work of the Cataract Power Company's works during the past four years. It is expected that power will be delivered in Fort William and Port Arthur by June 1st, 1906. The Ogilvie Milling Company have contracted for 2,000 horse power for delivery June 1st, 1906, for operating their new elevator and mill.

The Standard Inspection Bureau, Toronto, has been incorporated, with a capital of $40,000, by Messrs. J. Galt, A. L. Reading, T. C. Irving and H. E. Redman, to carry on the business of civil, mechanical and electrical engineers and inspectors.

The Canada Foundry Company, Limited, have made arrangements with E. T. Hanna, of Philadelphia, to manufacture in Canada the water tube boiler of which he is the patentee. This boiler has been made in the United States under the name of the "Atlas", and it is understood that the name to be adopted in this country will be the "Canada" water tube boiler.

MONTREAL ELECTRICAL SUPPLY FIRMS.

Montreal is a large user of electrical apparatus and supplies. Among the firms engaged in the repair and rewinding of electrical machinery are Fred Thomson & Company, 770 Craig street; Electrical Repair & Contracting Company, 617-619 Lagauchitiere street; Electrical Maintenance & Supply Company, 92 Prince street, and the Electrical Engineering Company, 18 Inspector street.

The supply firms include the R. E. T. Pringle Company, 769 Craig street; Allis-Chalmers-Bullock, Sovereign Bank Building; John Forman, 708 Craig street; J. A. Dawson & Company, 743 Craig street; Collyer & Brock, 1801 Notre Dame street; Montreal Electric Company, 354 St. James street; Eugene F. Phillips Electrical Works, Sanguinet and St. Charles streets; Munderloh & Company, 61 St. Sulpice street; Peacock Bros., Canada Life Building, St. James street; Sayer Electric Company, 14 Beaver Hall Hill; and the Hill Electric Switch Company, 426 St. Paul street.

Agencies are also located in Montreal of the Canadian General Electric Company, at 81 St. Peter street; the Packard Electric Company at 42 Street Railway Building, and the Canadian Westinghouse Company at 76 Liverpool & London & Globe Building.

The manufacture of telephones in Montreal is practically controlled by Messrs. Ness, McLaren & Bate, 732 Dorchester street, and the Northern Electric & Manufacturing Company, 371 Aqueduct street.

ELECTRIFICATION OF THE TEMISKAMING RAILWAY.

The Temiskaming and Northerd Ontario Railway Commission, of which Mr. Cecil B. Smith is chairman, have submitted to the Ontario Government a report on the adoption of electricity as the motive power for the operation of the first section of the Temiskaming Railway, a length of about 125 miles. It is understood that the report is somewhat favorable to electric traction and that the carrying out of the project will depend upon whether the Government feel disposed to provide the necessary money.

There are along this section of the road numerous accessible water falls for the generation of electric energy which it is believed can be developed at comparatively small cost. There are other local conditions, however, which also favor electricity, such as the heavy grades at many points and the necessity of protecting the forests from fire. As the road runs through the Temagami reserve, this latter is doubtless regarded as an important consideration.

THE WINDSOR & TECUMSEH ELECTRIC RAILWAY.

The Windsor & Tecumseh Electric Railway is to be equipped with 300 k.w. 3,300 volt Westinghouse single phase engine type generators direct coupled to a 450 horse power Robb-Armstrong Corliss engine. Two 200 horse power Robb-Mumford boilers, a large steel smoke stack, condenser and piping complete, will also be furnished by the Robb Company.

The car equipment will consist of two 50 h.p. Westinghouse single phase motors each. As this is the first single phase road in Canada, its development will be watched with considerable interest. One of the advantages of this equipment for short interurban roads is the elimination of feeders, sub-stations and raising transformers. The generator voltage is fed directly to the car through the trolley wire and step-down transformers are carried by each car.

PACIFIC COAST EXCURSIONS.

During June, July, August and September the Chicago and North Western Railway will sell from Chicago round trip excursion tickets to San Francisco, Los Angeles, Portland, Ore., (Lewis & Clarke Exposition), Seattle, Victoria and Vancouver at very low rates. Correspondingly cheap fares from all points in Canada. Choice of routes, best of train service, favorable stopovers and liberal return limits. Rates, folders and full information can be obtained from B. H. Bennett, General Agent, 2 East King St., Toronto, Ont.

Mr. B. F. Reesor has resigned the managership of the Lindsay Electric Light & Power Company, and has accepted a position as manager of the new power company which has been organized to develop and transmit power from Eugenia Falls, Grey county. Mr. Reesor's son has been appointed his successor at Lindsay.

As forecasted in last issue, Messrs. J. G. White & Company, electrical engineers and contractors, New York, have entered the Canadian field, operations to be carried on under the name of the Canadian White Company, Limited. The capital stock is $1,000,000 and the headquarters will be in Montreal. The charter is a broad one, giving the company power to carry on the business of electrical, mechanical and civil engineers and any business in which the application of electricity or any other power is or may be useful or convenient; to manufacture and produce any articles or products belonging to such business; to construct and operate works for the generation and distribution of electricity for different purposes, and to construct bridges, subways, tunnels, hydraulic works, machinery, etc. The incorporators are Messrs. W. G. Ross, R. C. Smith, R. C. Grant, W. W. Skinner and W. F. Chipman, all of Montreal.

SUNBEAM INCANDESCENT LAMP

THAT'S ALL

. . *Made in Canada by* . .

THE SUNBEAM INCANDESCENT LAMP CO.

OF CANADA, LIMITED.

Factory: **ST. CATHARINES.** Main Office: **TORONTO.**

SPARKS.

Mr. A. H. Campbell has been appointed general agent at Montreal of the Canadian Casualty & Boiler Insurance Company, with offices in the Liverpool, London & Globe Building, St. James street.

The Duncan Electric Company, Limited, has been organized in Montreal, with a capital stock of $90,000, to manufacture and deal in electrical apparatus and supplies. The incorporators are Messrs. Charles Duncan, W. P. Baird, Will King, Frederick Loomis and L. Williams, all of Montreal.

Position Wanted

Qualified electrical engineer with large experience in the operation of electrical and steam plant first-class technical education, desires position with electric lighting or power company or with electrical manufacturing firm.

For further particulars, testimonials, etc., address Box 25, ELECTRICAL NEWS, Toronto.

WANTED

Agencies wanted for electrical fixtures, specialties, automobiles, etc., etc. Address, ELECTRICIAN P.O Box 310 Woodstock, N.B.

Position wanted—By young man, strictly temperate, age 22 years, height 6 feet, weight 175 lbs. Technical education, experience in testing department of large electrical manufacturing works, and at construction work and wiring. First class references as to character and ability. Address Box 41, ELECTRICAL NEWS, Toronto, Ont.

GOOD BUSINESS OPPORTUNITY.

For sale.—Half interest in electrical fixture and supply company, $3,000 to $6,000 wanted to increase present business. Practical man preferred. Splendid showing $10,000 worth of contracts in hand at present. Full investigation solicited.

COOK'S BUSINESS EXCHANGE, Suite 3, 536 Hastings Street, upstairs, opposite Molsons Bank, Vancouver, B.C.

FOR SALE

1 Brush Arc Dynamo, 60 light, 9½ amperes.
2 Royal Electric Arc Dynamos, 40 light each, 9½ amperes.
1 S.K.C. Alternator, 133 cycles, 2,200 or 1,100 volts.
1 Marble Switchboard, 6 × 5 ft., 2 main switches, 3 meters.
40 Universal Arc Lamps in good condition, ⅝" carbons, single trim, 9½ amperes.
30 Royal Electric Arc Lamps, single trim, ½" carbons, 9½ amperes.
6 Lightning Arresters, direct current, Royal Electric make.

For further information apply to

THE OWEN SOUND ELECTRIC LIGHT DEPT.

Jos. McLinden, Foreman.

FOR POWER HOUSES WARE-HOUSES

CONVEYING MACHINERY

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ELECTRICAL ENGINEERS AND CONTRACTORS

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Electrical Work and Repairs of all Description. . . . .

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Estimates Cheerfully Given on Application.

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We manufacture TELEPHONES for all kinds of service Central, Exchange, Factory, Warehouse, etc. Our

DESK TELEPHONE

as illustrated is a handsome instrument. Perfect in construction and design, with no exposed contacts or wires, and has many other points of advantage.

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Any work in our line, large or small, will command our best attention.

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CANADIAN TURBINE WATER WHEEL

Canadian invention and original of all modern wheels. Forty years under improvement. High efficiency, great durability, sturdy power and easy gate. Vertical and Horizontal settings.

Chas. BARBER & SONS

MEAFORD, Ontario

JANDUS
ARC
LAMPS

FIG. 80

200 Hours for the Multiple D. C. Lamp
150 Hours for the Multiple A. C. Lamp

Bulletin No. 20—Send For It.

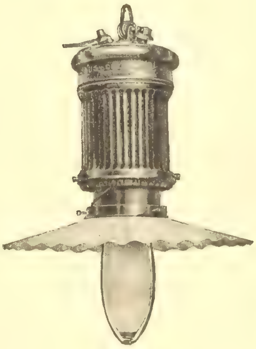

FIG. 82

Bulletin No. 21 Describes the Jandus Series Alternating System . . . . . .

CANADIAN REPRESENTATIVES

THE PACKARD ELECTRIC CO.
LIMITED

ST. CATHARINES
MONTREAL WINNIPEG

TRADE NOTES.

Messrs. C. W. Bongard & Company, of Toronto, advise us that they carry at all times 100,000 feet of "Loricated" iron conduit covering sizes from one half inch to three inch, besides a complete stock of "H" switches, Bossert boxes, pipe fittings and all sizes of insulated wires.

The Alberta Railway & Irrigation Company, of Lethbridge, N.W.T., have ordered a 175 horse power Robb-Mumford boiler from the Robb Engineering Company, of Amherst, N.S. This makes eight boilers of this type that this company have purchased during the past few years.

Mr. Herbert J. Armstrong has commenced business as a consulting mechanical and electrical engineer, with offices at 43 Victoria street, Toronto. Mr. Armstrong was for some years with the John Inglis Company, where he obtained an experience which should be valuable to him in the designing of complete power installations and manufacturing plants, of which he will make a specialty.

Attention is directed to the advertisement in this issue of Conduits Company, Limited. This company is the successor of the Richmondt Conduit Company. The new concern have purchased the rights for the manufacture of "Loricated" conduit and "Galvaduct"; the latter was formerly known as "Richmondt Conduit". The company are about to build a factory which will be equipped with new machinery for the manufacture of these goods. They are getting up a souvenir for the Canadian Electrical Association Convention in the form of a match box, on one side of which is a useful table of decimal equivalents.

Port Arthur, Ont., may enlarge its electric plant. Engineer McDougall has reported that another dam on the current river would give the town over double the present storage capacity. There is a large demand for both light and power and it has been found necessary to increase the electric railway system.

PERSONAL.

Prof. W. Muir Edwards, of Montreal, has been appointed professor of engineering at the University of New Brunswick at Fredericton, as successor to Prof. Jack.

Mr. H. V. Wilkinson, formerly of the Seattle branch of the Westinghouse Electric & Mfg. Company, has recently accepted the position of chief salesman for the Canadian Westinghouse Company in British Columbia.

The numerous friends of Mr. F. Hoffmeister, who was recently appointed Superintendent of the British Columbia Electric Railway Company, will regret to learn of the death of his wife, which took place at Weston, Ont., on June 3rd, after a somewhat prolonged illness.

Mr. S. C. DeWitt has been appointed Sales Agent for Allis-Chalmers-Bullock, Limited, Montreal, for the Maritime Provinces, with headquarters at Halifax. He is a graduate in electrical engineering of Lehigh University, Pennsylvania, and has had considerable experience in different lines of electrical work. For the past three years he was manager of the DeWitt Electric Company, with places of business at Sydney, Glace Bay, Pictou, Truro and Fredericton. He is a son of Dr. DeWitt, present Mayor of Wolfville, N. S., and being a native of the province and well acquainted with the business in the east, will no doubt prove a valuable acquisition to the staff of the company.

CLARKSON SCHOOL OF TECHNOLOGY
Thomas S. Clarkson Memorial, Potsdam, N.Y.
Organized under charter of the University of the State of New York.
Courses leading to degrees of Bachelor of Science in Chemical, Civil, Electrical and Mechanical Engineering, comprising four years of thorough training and resident college work in theory and practise of engineering. Copies of Clarkson Bulletin, published quarterly, mailed on application. Healthful climate. Tuition and living expenses moderate.
WM. S. ALDRICH, Director.

FOR SALE CHEAP

The following second-hand material, all of which is in first-class condition :—
1 Type F, C. G. E. Transformer, 1040 x 104 v. 1800 watts.
1 Type F, C. G. E. Transformer, 1040x75x150 v., 1000 watts.
1 New Type Royal Transformer, 1040x52 v. 500 watts
3 Reactive Coils—for Series Street Circuit.
3—3½ Amp. Indicators, " "
3—180 Amp. S. P. Knife Switches.
2 pair Outside Lightning Arresters, 1040 v.
A number of Outside Fuse and Junction Boxes.
Apply to Corporation of Bracebridge. WM. SIMMONS, Superintendent, Bracebridge, Ont.

THE GREATEST
responsibility resting upon our manufacturers and power users in Canada is that in connection with their Steam Plants. The Boiler Room is the place where precaution is taken.
The largest Steam Users regard the assistance of a responsible Company a necessity in order to provide protection and to insure a safe and economical maintenance of their Steam Plants.
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are specialists in Boiler Inspection, Consulting Engineers. We can save you money. Write us.
TELEPHONE MAIN 4091.
A. G. C. DINNICK, Managing Director

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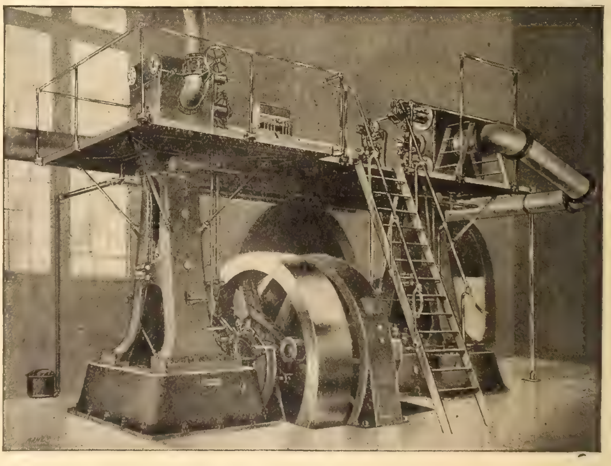
. . . Horizontal and Vertical . . .
Simple, Tandem and Cross Compound



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AGENTS { WILLIAM McKAY, 320 Ossington Avenue, Toronto.
WATSON JACK & COMPANY, Bell Telephone Bldg., Montreal.
J. F. PORTER, 355 Carlton St., Winnipeg.

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(Successor to the Electrical Supervision Society)

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ELECTRICAL & MECHANICAL ENGINEER
16 KING ST. W. TORONTO

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Long Distance Power Transmissions.
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Reports, Estimates, Arbitrations.
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A Weekly Journal of advance information and public works.
The recognized medium for advertisements for 'Tenders.
CANADIAN CONTRACT RECORD
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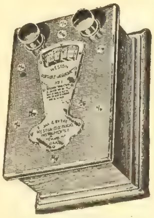
TELEGRAPH, TELEPHONE AND ELECTRIC LIGHT
POLES
OSWEGO, N. Y. - - - BANCROFT, ONT.

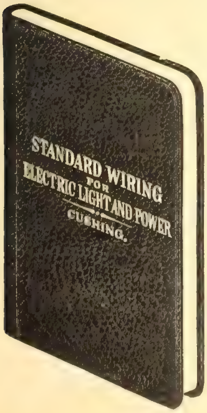
ALUMINUM
ELECTRICAL CONDUCTORS
FOR
RAILWAY FEEDERS and TRANSMISSION LINES . .
INGOTS, SHEETS, WIRE, TUBING, CASTINGS
Prices with full information on application.
NORTHERN ALUMINUM CO.
PITTSBURGH, PA.

WESTON ELECTRICAL INSTRUMENT CO.
Main Office and Works, Waverly Park, NEWARK, N.J., U.S.A.
New York Office : 74 Cortlandt Street.
Berlin : European Weston Electrical Instrument Co., Ritterstrasse No. 88.
London : Elliott Bros., Century Works, Lewisham.
Paris, France : E. H. Cadiot, 12 Rue St. Georges.


Weston Portable Galvanometer—for Bridge Work.

WESTON STANDARD PORTABLE
Direct-Reading
VOLTMETERS, MILLIVOLTMETERS,
VOLTAMMETERS, AMMETERS,
MILAMMETERS, GROUND DETECTORS
AND CIRCUIT TESTERS,
OHMMETERS, PORTABLE GALVANOMETERS

Our Portable Instruments are recognized as THE STANDARD the world over
Our STATION AMMETERS and VOLTMETERS are unsurpassed in point of extreme accuracy and lowest consumption of energy.



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STANDARD WIRING
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By the Fire Underwriters of the United States.
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By over 47,000 Electrical Engineers, Central Station Managers and Wiremen.

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It is the only book on Wiring and Construction kept strictly up to date.
It contains all the necessary Tables, Rules, Formulas and Illustrations.
It settles disputes, and if referred to before wiring will prevent disputes.

Flexible Leather Cover, Pocket Size, Retail Price - - $1.00 Each

Address orders to Canadian Electrical News, Toronto, Can.

SPARKS.

Allis-Chalmers-Bullock, Montreal, are now engaged in installing the electric plant at Calgary, N. W. T.

The lighting plant of Moncton, N. B., will be doubled when the improvements now under way are completed. An 800 k. w. C. G. E. generator and a Robb-Armstrong engine are being installed.

The by-law giving the city of Ottawa authority to purchase the plant and lines of the Consumers Electric Company was carried last month by a majority of 453. The proposed expenditure is $200,000.

The John McDougall Caledonian Iron Works Company, of Montreal, are supplying a two-speed motor, direct connected to a Worthington 6-inch, two-stage turbine pump, to the town of Renfrew, Ont., for waterworks pumping.

Mr. George L. Brown has made a survey of the canal bank at Morrisburg, Ont., with a view to locating a site for the proposed coffer dam and power house. This is a municipal enterprise.

As announced in last issue, the Brantford Electric & Operating Company, Brantford, Ont., have retained the services of Mr. R. S. Kelsch, consulting engineer, Montreal, in connection with the reconstruction of the entire plant and system, including the removal of grass and weeds that obstruct their hydraulic canal and at times are a serious menace to the water-power. The plans contemplate changing the system from 133 to 60 cycles and the installation of a complete new steam reserve plant, also changing the d c. open arcs to constant current a. c. enclosed lamps. When the changes are completed, the Brantford Electric & Operating Company will have one of the finest plants in the province of Ontario.

"LOHYS" Electrical Stampings and Sheets.
"COHESIVE" Inner Globes
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FOR ENCLOSED ARC LAMPS.

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Standards of the World—"Galvaduct," "Loricated."

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A few of the many buildings equipped with our conduits:

King Edward Hotel	Toronto
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Toronto Electric Light Power Houses	"
New School of Science	"
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Osler & Hammond Building	"
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Canadian Kodak Co. "	"
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Montreal Light, Heat & Power Co.	"
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Sherwin Williams Buildings	"
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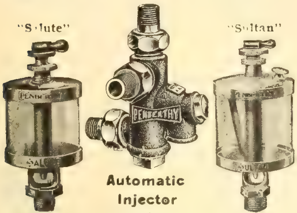

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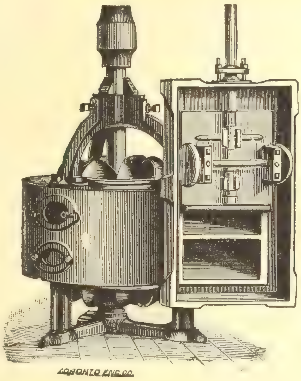
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HORIZONTAL AND VERTICAL.

Made in 44 sizes, from 4 inches to 60 inches diameter, in either iron scroll case (see cut) or in flume case.

Complete stock of turbines on hand to insure prompt shipment.

Machine dressed gearing a specialty.

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Correspondence solicited.

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Cablegrams : Glenyards, Bonnybridge. Codes used, A.B.C. and Glenyards.

Manufacturers of all kinds of **Fire Clay Goods, Ganister and Silica Goods, for Iron and Steel Works and Gas Works, including Boiler Seating Blocks and Covers of all sizes. Ground Fire Clay, Ganister and Silica** in all kinds of Packages

SPARKS.

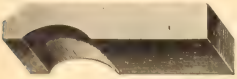
City Electrician McCrossen, of Vancouver, B. C., has recommended a change in the lighting system of that city and the Council will consider the matter.

The Ontario Government propose to operate a portion of the Temiskaming and Northern Ontario Railway by electric power. There are numerous available water powers in the district.

Owing to the electrifying of the railroad between Vancouver and Steveston, B.C., the business houses and many of the residences in the latter town are being wired preparatory to the advent of electric light. The Confederation Canning Company's whole plant has been wired by the A. F. Barber Electric Company of Vancouver.

Vancouver electricians claim that they are "up against it" owing to competition being so keen that prices are being cut below living rates. This, it is claimed, is caused by employees getting out of work and then starting contracting for themselves. The result is that price cutting has been quite general and it is hardly possible to operate without a loss.

ELECTRICAL & TRANSFORMER SHEETS, STRIPS & STAMPINGS
SWEDISH BARS, ROUNDS, SQUARES, FLATS



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TURNER BROS., 134 UPPER THAMES ST. LONDON, ENG.

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MAGNET STEEL FOR PERMANENT MAGNETS.
BRIGHT CHARCOAL IRON RODS

Sole Representatives for Canada: Peacock Brothers, Canada Life Buildings, Montreal.

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TRADE MARK
REGISTERED

FLEXIBLE CONDUIT

MONTREAL ELECTRIC COMPANY, AGENTS.

The ORIGINAL and only GENUINE "Circular Loom." Has been in the market for twelve years, and handled by us for over nine years. No other substitute has ever taken its place for quality and adaptability. For price lists, discounts and full information, address

Montreal Electric Company, 354 St. James Street, **Montreal**

Instant shipment made. Large stock of all sizes always on hand.

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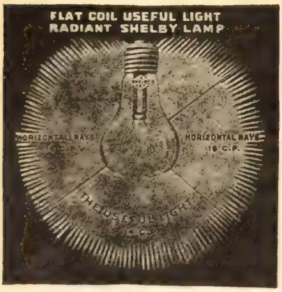

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(*Patented in Canada.*)

We manufacture the Radiant Shelby and the Downward Light Tipless Lamps, either of which produces fifty per cent. more useful light, and does not consume any more current than the ordinary type lamp.

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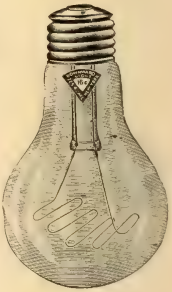

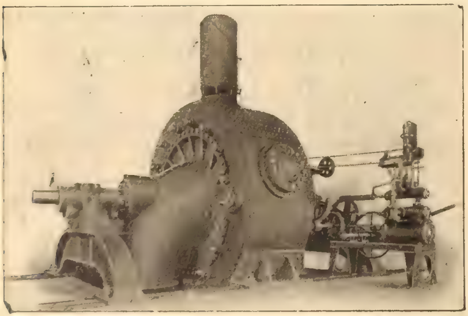

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For all Power Purposes

We guarantee for this turbine greater power and speed and easier regulation than can be obtained from any other water wheel of the same size operating under similar conditions.

Efficiency is over 80°/₀.

BUILT BY

The Wm. Hamilton Manufacturing Co., Limited

ranch Office: Vancouver, B.C. - - Peterborough, Ont.

Westinghouse

"Type F" Automatic Circuit Breaker

An Adjustable Carbon Break Circuit Breaker

For either Alternating or Direct Current Circuits

Costs only slightly more than a switch with enclosed fuses

Occupies Little Space
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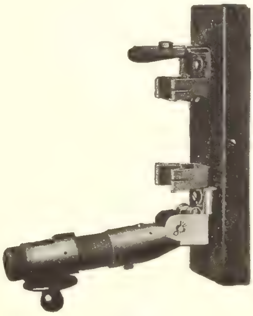
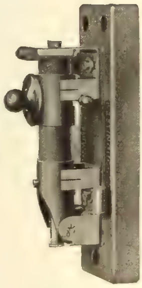
For All Capacities



Open



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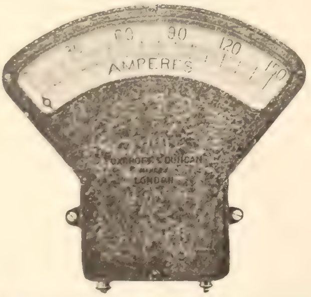

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No. 7.

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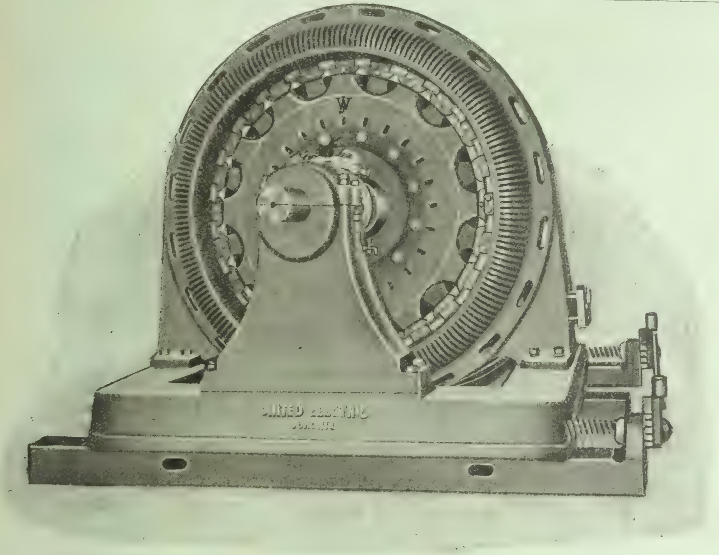

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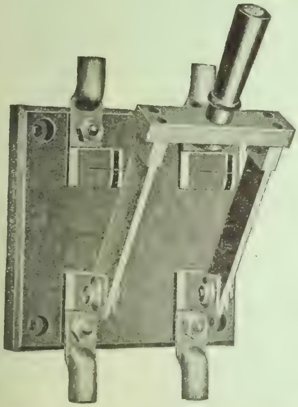

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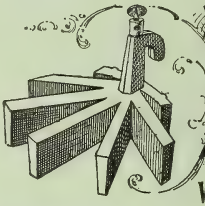

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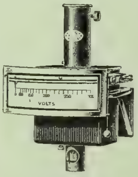

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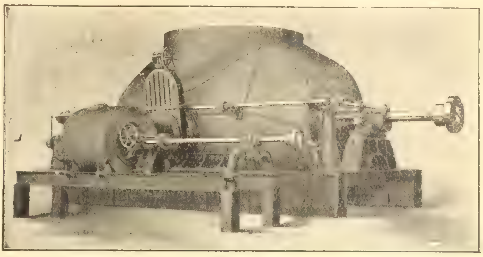

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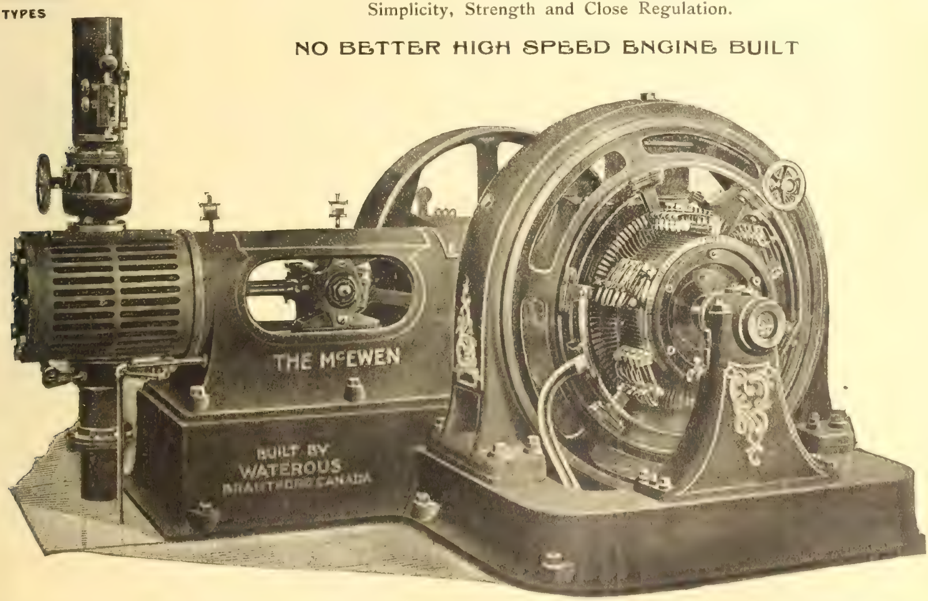

WATEROUS, BRANTFORD, CANADA

SPARKS.

A by-law was carried at Mitchell, Ont., recently to raise $8,500 to complete the waterworks and electric light plants.

Mr. J. Bradley, a local electrician, has been requested to report on the outlook for an electric light plant at Fort Frances, Ont., under municipal control.

Mr. G. F. Grant has submitted a favorable proposition to supply electric power for Calgary, N.W.T. His price, if 150,000 watts per month are used, would be one cent per watt.

The Water and Light Commissioners of Woodstock, Ont., have submitted estimates for a comprehensive scheme of improvements to cost $50,000. The purchase of two generators for $5,200 is recommended.

The Toronto and Niagara Power Company have just taken tenders on three brick division stations to be erected at the following places: One at Stoney Creek, one at Twenty-Mile Creek and one at Clarkson's.

The City Engineer of Toronto has reported that it would cost $90,000 to install an electric plant for lighting the Island, and as the Legislature empowered the city to spend only $40,000, the proposal will probably be dropped.

An electric light plant is to be installed in the City of Salaberry de Valleyfield, Que., for which tenders will be received by Mr. C. Lavimodiere, City Clerk, up to July 18th. The consulting engineer is Mr. Charles Brandeis, Montreal.

Ald. Douglas has moved the following resolution in the City Council of Victoria, B.C.: "That in the event of the city acquiring the water from Goldstream, the city electrical engineer be instructed to make a report on the probable cost of installing a plant for the city's lighting purposes."

The Glenora Power Company, Limited, has been incorporated, with head office at Picton, Ont., to develop water powers and distribute electric current. The provisional directors are Messrs. Wellington Boulter, D. L. Bongard and W. J. Carter, of Picton, Evans Foster, of Wiarton, and W. H. Crowe, of Welland.

Mr. John Yule has submitted to the Light and Power Committee of Guelph, Ont., an estimate of the probable cost of additions and improvements to the electric plant. This he places at $12,061, including $1,831 for a 120 k.w. A.C. generator, switchboard and exciter, with wiring connections, $4,030 for a 200 h.p. compound-condensing engine with steam pump, valves, etc., $1,750 for transformers, $2,250 for meters and $1,500 for branch lines in various parts of the city. His figures were based on the purchase of a generator that had been a short time in use.

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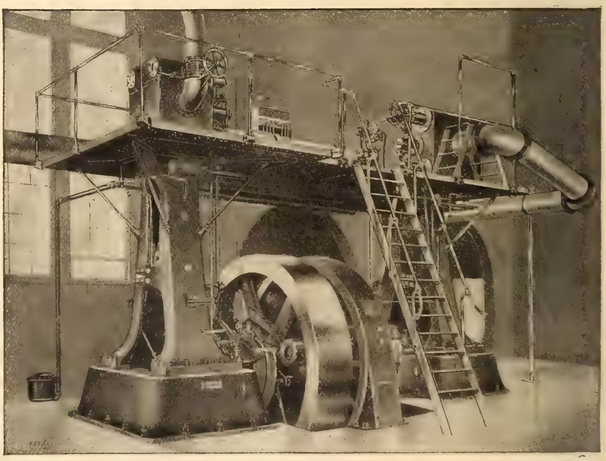

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SPARKS.

The Eclipse Manufacturing Company, manufacturers of smoke consumers, etc., Montreal, have registered their business.

Mr. W. H. Green, proprietor of the electric light plant at Teeswater, Ont., is considering the installation of additional apparatus.

Mr. H. N. Kittson, of Hamilton, has been elected president of the Central Ontario Power Company, of which Mr. J. A. Culverwell is managing-director.

Barton & Company, manufacturers of motors, etc., London, Ont., have been succeeded by the Maple Leaf Automobile and Electrical Manufacturing Company.

The Canadian Fire Protection Company, Limited, has been incorporated, to acquire the business of the Cortlandt Electrical Manufacturing Company, Toronto.

The Goldie & McCulloch Company, of Galt, Ont., were the successful tenderers for the supply of engine, condenser, pump and piping for the City of Guelph, their figure being $2,957.

A new agreement has been reached between the Seaforth Electric Light Company and the Town Council. The Company agree to furnish improved arc lamps for the lighting of the streets for $65 per lamp per year, also six incandescent lamps of 32 c. p. each for 65c. per lamp per month.

The Automatic Train Stopping Company, Limited, has been incorporated, to manufacture the McPhee automatic railway signalling device. The company is capitalized at $250,000 and the head office is in Toronto. The promoters include Messrs. H. W. Bickell, J. C. Kelly, W. R. P. Parker, George M. Clark and J. V. McEvoy, all of Toronto.

The Town Council of Indian Head, N.W.T., are taking tenders up to July 17th for waterworks and electric lighting machinery, including a 150 k.w. a.c. generator with direct-connected engine and exciter, a water tube boiler and the supply of all neccessary poles, transformers, arc lamps, etc., for an electric light distribution system. Mr. John Galt, C.E. & M.E., Toronto, is the consulting engineer.

The company which proposes to develop the water power of the Kakabeka Falls, near Fort William, Ont., has been incorporated under the name of the Kakabeka Power Company, Limited. The capital is placed at $2,000,000. The incorporators include Messrs. H. S. Holt, president of the Montreal Light, Heat and Power Company ; Charles R. Hosmer, director of the Canadian Pacific Railway, and Frederick W. Thompson, general manager of the Ogilvie Flour Mills Company.

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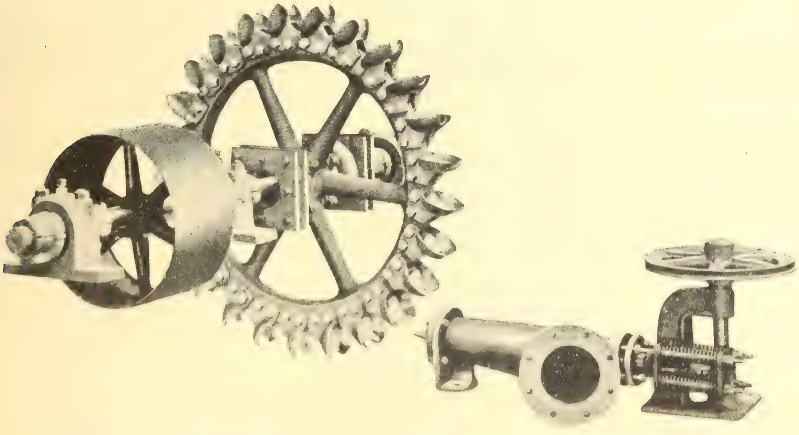

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Catalogue on Application - - Builders in Canada

SPARKS.

An electric plant is being installed in the Fairview Hospital at Vancouver, B.C.

The extension of the electric light plant at Goderich, Ont., is being considered by the Town Council.

Mr. Johnston, of Regina, N.W.T., has submitted a proposition to install an electric light plant at Saskatoon.

The question of extending the electric light plant at St. Mary's, Ont., is still being considered by the Town Council.

The Corporation of Dalhousie, N.B., will probably install waterworks and sewerage and an electric light plant.

It is reported that the Canadian Pacific Railway Company are considering the building of an electric railway between New Westminster, B.C., and Steveston.

It is understood that the City Council of Victoria, B.C., will be petitioned to submit a by-law to the ratepayers to provide for a sufficient sum of money to enlarge the electric light plant.

Senator Mitchell, of Amherst, N.S., is interesting himself in a project to construct a central power station at Chignecto Mines for the purpose of supplying power to Amherst industries.

The plans of the Stave Lake Power Company, of Vancouver, B.C., have been approved by the Government. The work is to be commenced by June 1, 1906, and completed by November 1, 1908.

It is again reported that the C.P.R. will adopt electric power for the operation of their road between Rossland and Nelson and that the energy will be obtained from the West Kootenay Power & Light Company.

The Sun Life Insurance Company, of Montreal, have secured a majority of the shares of the Stormont Electric Light & Power Company, and now control the street railway, electric light and gas supply of Cornwall, Ont.

The annual meeting of the St. John Street Railway Company was held recently, the directors report then submitted showing a net profit of $52,034.44 The report says:—"We regret to report that the city of St. John, having applied to the provincial legislature for certain important modifications in the charter rights of this company, succeeded in imposing upon us important changes in the matter of maintenance and care of the streets upon which this railway is operated, much to the company's disadvantage. We view with alarm, which must be shared by other companies doing business in this province, the action of the legislature in so enacting that a charter given by them can be changed in this way, as such in our opinion must have the effect of seriously damaging the credit of present and future enterprises in this province; but we trust that on serious consideration by the government these modifications will be annuled. The city, fully realizing their obligations to this company, entered into a contract dated 1st December, 1897, running for ten years, under which instead of maintaining the streets the company pays a fixed sum. This contract has two years still to run, and the modifications imposed upon us do not take effect until it expires, by which time we hope, as we have stated above, we shall be relieved from these new obligations." At a subsequent meeting of the directors the resignation of Mr. J. M. Robinson as vice-president was accepted and the following officers elected: President, James Ross; vice-president, Col. H. H. MacLean; directors, James Manchester, R. B. Emerson, M. Neilson, Wm. Downie, Col. Tucker and H. B. Robinson.

MOONLIGHT SCHEDULE FOR AUGUST.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Aug. 1	7 50	Aug. 2	4 00	8 10
2	7 50	3	4 00	8 10
3	7 50	4	4 00	8 10
4	7 50	5	4 10	8 20
5	7 40	6	4 10	8 30
6	7 40	7	4 10	8 30
7	10 00	8	4 10	6 10
8	10 30	9	4 10	5 40
9	11 20	10	4 10	4 50
11	0 10	11	4 20	4 10
12	1 00	12	4 20	3 20
13	2 00	13	4 20	2 20
14	No Light	14	No Light	
15	" "	15	" "	
16	7 30	16	9 30	2 00
17	7 30	17	9 50	2 20
18	7 30	18	10 20	2 50
19	7 20	19	10 50	3 30
20	7 20	20	11 20	4 00
21	7 20	21	11 50	4 30
22	7 20	23	0 30	5 10
23	7 20	24	1 00	5 40
24	7 20	25	1 50	6 30
25	7 20	26	2 40	7 20
26	7 10	27	3 30	8 20
27	7 10	28	4 30	9 20
28	7 10	29	4 30	9 20
29	7 10	30	4 30	9 20
30	7 10	31	4 30	9 20
31	7 10	Sept. 1	4 30	9 20
			Total	175 10

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PERSONAL.

Mr. Charles Aubin, Montreal, has been appointed assistant inspector of gas and electric light in that city.

Mr. Thomas Ahearn, of Ahearn & Soper, Ottawa, received congratulations from many friends on Saturday, July 1st, on attaining the fiftieth milestone in the journey of life.

Mr. Charles Chaplin, M.Sc., late demonstrator in civil engineering at McGill University, Montreal, has assumed the position of mechanical engineer of the Dominion Arsenal, Quebec.

Mr. Henry Oestreich, who has been in charge of the Waterloo Electric Light and Power Plant at Waterloo, Ont., has severed his connection with the above plant and Mr. Geo. Grosz is now in charge.

Mr. Harry V. Croll, M. E., for the past eight years with the E. P. Allis Company and their successors, Allis-Chalmers Company, of Chicago, has resigned and accepted a position with The Wellman-Seaver-Morgan Company, of Cleveland Ohio

Mr. W. A. Stadelman, Eastern Agent of The Wellman-Seaver-Morgan Company, and who has been in charge of the Eastern office at 42 Broadway, New York City, has been appointed General Sales Agent of the same company, with headquarters at Cleveland, Ohio, taking effect July 1st. Mr. Fred Stadelman has been appointed Assistant Manager of the New York office of The Wellman-Seaver-Morgan Company.

Mr. B. F. Reesor, of Lindsay, Ont., who recently resigned from the management of the Lindsay Light, Heat & Power Company to become managing-director of the Georgian Bay Power Company, was presented by the employees of the company with an address and a beautiful solid leather suit case bearing his name in gold letters. Mr. Reesor carries with him to his new position the best wishes of the citizens of Lindsay.

Mr. M. C. McKay, who installed the Vancouver Power Company's plant at Lake Beautiful, has severed his connection with the company and has been appointed superintendent of the Britannia Copper Company's power house. He was presented by the officials and employees of the Vancouver Power Company with a handsome set of drafting instruments as a memento of his connection with the harnessing of the power of lakes Beautiful and Coquitlam.

Mr. E. C. Reeder, mining engineer, who has just been appointed representative of Allis-Chalmers-Bullock, Limited, at Nelson, B. C., is a native of Michigan, and received his education in the public schools of that State. He graduated later from the Michigan College of Mines as mining engineer, and supplemented his college work with courses at the Massachusetts Institute of Technology. He had several years practical experience in Montana after graduating, where he worked as a miner and smelter man in the mines and smelters at Butte. Later he went to Utah, where he held responsible positions as foreman and engineer for several of the large mining and smelting companies of that city.

ONTARIO POWER COMMISSION.

The Ontario Government, at a Cabinet meeting on July 4th, appointed the electrical power commission foreshadowed in the speech from the throne at the opening of the Legislature. The commission is composed of Hon. Adam Beck, M. P. P., London; Mr. P. W. Ellis, manufacturer, Toronto; and Mr. George Patinson, M. P. P., of Galt. They are authorized to collect all information possible in regard to water powers suitable for the development of electric energy, estimates as to the cost of such development, the cost to manufacturers in comparison with the cost of steam power, etc. Thus it will be seen that the scope ol the commission is wide.

The Pembroke Electric Light Company, Pembroke Ont., have purchased the Black River water power, where it is proposed to develop about 3,000 horse power. It is said that the company expect to be able to supply power at a very low rate.

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Electrical Construction Co. of London	IV
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Starr, Son & Co. John	xiii
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United Electric Co.	I, IV

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Canada Metal Co.	II
Chase - Shawmut Co.	xv
Philips Electrical Works, Eugene F.	I
Wire & Cable Co.	

TRADE MARK

"Diamond H" Switches

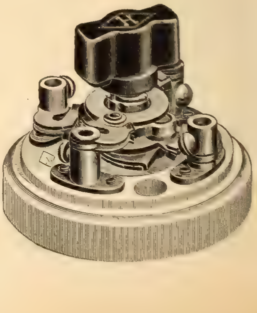
Made by
Hart Mfg. Coy.

Push Flush Switches
Flush Receptacle and Plug
Automatic Door Switches
Rotary Flush Switches
Steel Wall Appliances
Rotary Standard Switches

Send for Catalogue B.

. . . Agents . . .

C. W. BONGARD & CO.,
Toronto, CANADA



SPARKS.

A new electric power station is being built by the corporation of Sydney, N. S.

The Toronto Incandescent Light Company are building an addition to their power house on Terauley street.

The Chairman of the Civic Electric Light Committee of Parry Sound, Ont., has reported in favor of an expenditure of $17,000 in improving the plant.

A by-law to raise $15,000 for the extension of the waterworks and electric light plants at St. Mary's, Ont., was defeated recently by a small majority.

The Wallacetown and Lake Shore Telephone Association began operation last month, with 18 'phones on the line. The cost of construction was about $40 per mile.

A new company has made application for a franchise for gas and electric lighting at Galt, Ont., and the existing company have offered to sell their plant to the town.

The Portland Mica Company, Limited, of Ottawa, Ont., was formed last month, with a capital of $6,000. Mr. F. W. Webster, mica dealer, of Boston, is one of the promoters.

It is understood that the Canadian Pacific Railway Company are considering the installation of an electric plant at Owen Sound, Ont., for lighting their buildings and for the operation of the coal hoisting plant.

The City Council of Sherbrooke, Que., by a vote of nine to two, last month rejected the offer of the Sherbrooke Power, Light & Heat Company to sell their plant to the city for $233,000.

The Georgian Bay Power Company, of which Mr. B. F. Reesor, of Lindsay, has been appointed managing-director, are about to commence the construction work for the development of electric energy at Eugenia Falls. It is proposed to transmit the power to Owen Sound and other points.

The Duncan Electric Company, Montreal, have started to install their machinery, which will occupy a floor space of over 1,000 square feet. They expect to be manufacturing electrical supplies of all descriptions and a number of specialties in the course of a few days.

The Canadian Seamless Wire Company, Limited, has recently been incorporated, with a capital of $50,000. It is proposed to manufacture plated and other wire and metallic tubing. The head office will be in Toronto. The promoters are Americans, including Messrs. W. B. Gladding and E. H. Fairbrother, of Providence, Rhode Island, and H. E. Smith and H. P. Smith, of Cranston, Rhode Island. Mr. D. W. Saunders, of Toronto, is also interested.

The Winnipeg Street Railway Company are building a distributing station on Mill street for the reception of the power to be developed at Lac du Bonnet by the General Power Company. The development at Lac du Bonnet will be about 30,000 h.p. and the initial installation will consist of four 1,200 k.w. and two 2,000 k.w. generators, which are being furnished by the Canadian General Electric Company. There is a 45 foot head.

The Town Council of Meaford, Ont., by a vote of five to two, last month decided to engage in electric lighting on its own account and also to substitute electricity for steam for the pumping of water. Two tenders were submitted for lighting the town, Mr. John Sutherland, of Toronto, tendering at $40 per lamp per year for a midnight service and $50 for an all-night service, and Mr. F. Leggatt, of Meaford, at $45 and $50 respectively. The town will likely purchase the plant of W. Moore & Sons, who, by the way, did not submit a tender.

GILBERT PRISM GLASS
REFLECTING SHADES

SAYER ELECTRIC
MONTREAL

GARTON DANIELS LIGHTNING ARRESTERS

The Garton Daniels Lightning Arresters are devices made in many styles, for use on Electric Railway, Light and Power Circuits, both for Direct and Alternating Currents. They offer the discharge a path to earth of low resistance.

They also cut off the flow of normal current so that your circuits will not be grounded.

If you are interested we will mail you a pamphlet.

The R. E. T. PRINGLE CO., LIMITED
Manufacturers and Dealers in
ELECTRICAL APPARATUS AND SUPPLIES
ST. JOHN, N. B. MONTREAL, QUE. TORONTO, ONT.

TRADE NOTES.

Messrs. Turner Bros, of London, England, desire to bring to the notice of the electrical trade their improved non-ageing transformer sheets, tests of which have given excellent results.

The Town of Dauphin, Manitoba, has ordered from the Robb Engineering Company, Amherst, N. S., two 100 horse power boilers and a 100 horse power engine for the electric lighting plant which the town is installing.

The name of the Babcock & Wilcox Company was inadvertently omitted from the classified list of advertisers in our June number. Their advertisement appeared on page vii and stated that over 5,000,000 horse power of the well-known Babcock & Wilcox water-tube boilers are now in use.

Messrs. C. W. Bongard & Company, western agents for the Wire and Cable Company, Montreal, last month received an order from the Midland Construction Company, of London, Ont., for about 100,000 pounds of trolley wire. This company is building an electric railway from London to St. Thomas.

The Vancouver Engineering Works have recently supplied the Iron Mask Mine at Kamloops with a 48″ × 14′ boiler, 120 lbs. working pressure, to operate the sawmill which is worked in connection with the Iron Mask Mine. This mill was operated by the two main boilers at the bottom, but owing to the installation of the new smelter these boilers were crowded to their utmost capacity and it was thought advisable to install separate boilers for the sawmill. A novel feature in connection with transportation to the Kamloops Mines is the mode of getting freight from the railway up to the mine. A heavy traction engine is used, drawing two large iron waggons which have a capacity of fifteen tons, and the freight is loaded on these waggons and hauled to the mine.

The Clinton Electric Light Company, Clinton, Ont., have agreed to give an all night service on the condition that the town put in six more arc lights.

The Commissioners at Fort William, Ont., have decided to extend the telephone system to Kakabeka Falls and have substations at Stanley and Slate River, a distance of 20 miles.

SPARKS.

It is proposed to operate the new grain elevator at Port Colborne, Ont., by electricity.

An extension of the electric lighting system at Newmarket, Ont., is contemplated by the Town Council.

The Fort Wayne Electric Company, of Fort Wayne, Ind., are supplying some arc lamps for the city of Kingston, Ont.

Messrs. W. J. Stevenson and W. J. Nediger have taken over the electric light plant at Clinton, Ont.

The Levis Electric Railway, Levis, Que., was sold by sheriff's sale June 19th and was purchased by Mr. John Forman, of Montreal, for $50,000.

The Hamilton Cataract Power, Light & Traction Company have purchased a controlling interest in the Lincoln Light & Power Company, of St. Catharines, Ont.

The British Columbia Telephone Company have extensive improvements in contemplation and have awarded a contract to J. Brombley, of Phoenix, for the supply of 1,200 cedar poles for the new line to be built from Cascade to Phoenix.

The British Columbia Electrical Construction Company, of Vancouver, has recently changed hands, the purchasers being Messrs. Laidlaw Bros., of that city. They purpose carrying on the same line of business, making a specialty of wiring and fitting.

Another roller bearing company has been incorporated in Toronto, to be known as the Brintnell Adjustable Roller Bearing Company, Limited. The provisional directors are: Messrs. Alexander Nelson, E. H. Adams, A. S. Dewar, A. H. Lougheed, W. H. Scott, C. D. Scott, J. E. Cook and A. H. Brintnell, the latter being the inventor.

At a meeting of the Mexican Light & Power Company held in Montreal recently, the shareholders authorized the Board of Directors to organize the Mexican Electric Light Company, Limited, to acquire the properties of the two other companies now doing business in the city of Mexico. The former company have just received a contract to supply 5,000 horse power to the Street Railway Company and 2,000 horse power for pumping purposes.

Dynamos and Motors
SMALL and LARGE

SAYER ELECTRIC
MONTREAL

STEAM PLANTS

We can supply complete steam plants for any purpose. This will include **Engines** (Wheelock, Corliss or the Ideal high speed), **Boilers, Condensers, Pumps, Heaters, Piping, Valves** and all other accessories. We make a specialty of Electrical Power Plants.

---SEND FOR ESTIMATES---

THE GOLDIE & McCULLOCH CO., LIMITED
GALT, ONTARIO, CANADA

We Make Wheelock Engines, Corliss Engines, Ideal Engines, Gas and Gasoline Engines, Boilers, Steam and Power Pumps, Water Wheels, Oatmeal Mill Machinery, Flour Mill Machinery, Gyrators, Wood-Working Machinery, Shingle Machinery, Heading and Stave Machinery, Wood Rim Split Pulleys, Iron Pulleys, Shafting, Hangers, Gearing, Couplings, Friction Clutch Couplings, Clutch Pulleys, Safes, Vaults and Vault Doors.

ELECTRIC BELLS
BATTERIES AND SUPPLIES

SAYER ELECTRIC
MONTREAL

Pittsburgh Transformers.

Quick Delivery and Price.

Pittsburgh may seem quite a long ways from some places in Canada but after all it does not take long to get transformers to you. Shipments via Buffalo usually cross the border on the third day and then we are as near as anybody else is.

Another thing, we are three days to three weeks ahead of most factories in making shipments of orders. That is because of unusually efficient shop and office system, and perhaps, also, because we make nothing but transformers.

And one more thing, an important one too, we can doubtless save money for you on your transformer purchase, so that it is well worth while to write for our price list and proposal form.

Pittsburgh Transformer Company
Pittsburgh, Pa

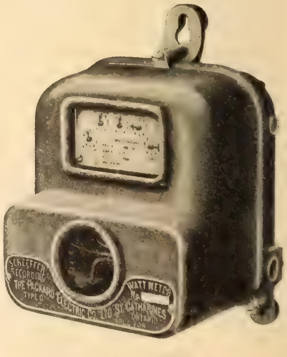
Packard

WHERE THEY ARE MADE

TYPE "R"

THE PACKARD
ELECTRIC CO.
LIMITED

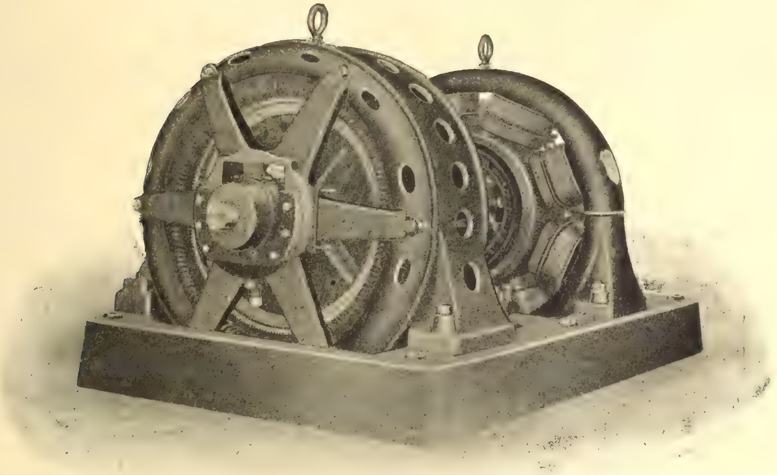
St. Catharines
Montreal Winnipeg



Type "G"

ALLIS-CHALMERS-BULLOCK

LIMITED



One of our 300 h. p. Induction Motors and a 200 k. w. Generator forming the exciter set for the great frequency changer at the Montreal Substation of the Shawinigan Water and Power Co.

COMPLETE ELECTRIC AND MINING PLANTS

Builders of the Machinery of the Allis-Chalmers Co., Milwaukee; the Bullock Electric Mfg. Co., Cincinnati; the Ingersoll-Sergeant Drill Co., New York; the Lidgerwood Mfg. Co., New York.

Works: MONTREAL.
Offices: HALIFAX, TORONTO, WINNIPEG, NELSON, VANCOUVER.

For **Switchboards and Panelboards**

COLLYER & BROCK

MONTREAL

Also Manufacture: **Conduit Boxes, Bushings, Locknuts and Fittings of every description, as well as Knife Switches and Enclosed Fuses.**

GET OUR PRICES BEFORE ORDERING.

LINE AND CONSTRUCTION MATERIAL

STEEL POLES
TIES
HANGERS
STRAIN INSULATORS
WOODEN POLES

BARE, RUBBER COVERED AND WEATHERPROOF WIRES AND CABLES
EARS
STOMBOUGH GUY ANCHORS

LIGHTNING ARRESTERS
BRACKET ARMS
RAIL BONDS
INSULATORS
GUY WIRE

- - - ALSO - - -

CAR SEATS
TROLLEY BASES
WHEELS AND HARPS
FIELD COILS

TROLLEY CORDS
INSULATING MATERIALS
CAR CURTAINS
TROLLEY POLES

GEARS AND PINIONS
ARMATURE COILS
HARD FIBRES
TAPES

and Street Railway and Electrical Material of Every Description.

Prompt Shipment from Stock at Right Prices for Reliable Material.

J. A. DAWSON & CO., 743 Craig Street, MONTREAL, QUE.

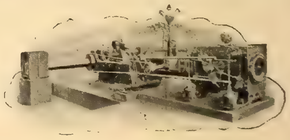
JENCKES-CORLISS ENGINES

Branch Offices from Ocean to Ocean

Our type of Corliss is distinguished by good design, superior workmanship and high efficiency.

Built in Medium and Heavy Duty Patterns, Simple and Compound Styles, Condensing and Non-Condensing.

Correspondence invited.



The JENCKES MACHINE COMPANY
LIMITED
54 Lansdowne Street SHERBROOKE, QUE.

ANNOUNCEMENT

Gutmann Meters

As some of our competitors have circulated the report that an injunction had been obtained restraining the manufacturers of the Gutmann Meter from making these celebrated instruments here, we would say that such is not the case. We have a large stock on hand and a large shipment on the way from our Canadian Factory and can ship all orders immediately upon receipt.

JOHN FORMAN

ELECTRICAL SUPPLIES - 708-710 Craig Street, MONTREAL

CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XV. JULY, 1905 No. 7.

ANNUAL REPORT OF LIGHT AND POWER COMPANY.

The fourth annual report of the Montreal Light, Heat and Power Company, recently submitted, showed that the gross revenue for the year amounted to $2,901,264,67, and the net profits, after providing for fixed charges, interest, etc., to $1,128,789.05, being an increase over the previous year of $311,818,17 gross, and $244,775,20 net. The report says:

There are now under construction at the present time two new electric distributing stations of 10,000 h.p. capacity each, one to supply the east end and the other the north end of the city. Both of these stations will be absolutely fireproof, and the electrical apparatus installed in same is the best and most modern that can be secured.

Your directors acquired by purchase the Provincial Light, Heat & Power Company, which controls, for the province of Quebec, the St. Lawrence Power Company, Limited, and owns the rights to all the surplus water of the Soulanges canal, and it is the intention to utilize the power from this source as soon as conditions warrant same.

During the year your directors entered into a 25-year contract with the Montreal Street Railway Company for an additional 7,000 h.p. of electric current, 4,000 h.p. of which is to be supplied by the 1st of July next, and the balance as the railway company may require same.

The extent of the increase in the company's business will be realized when it is noted that during the year 463 electric meters were installed, and 936 electric customers, representing 24,842 incandescent and 86 street arc lamps, and 53 motors, equivalent to 4,793 h.p., were added to the company's circuits. There were also installed during the year 4,390 gas meters, 2,304 gas stoves and 1,557 new gas services, and 26.47 miles of new mains and services were laid. At the close of the year there were connected to the service over 55,000 gas and electric meters, and the prospects for additional business for the coming year are most favorable.

DELEGATES AND FRIENDS, CANADIAN ELECTRICAL ASSOCIATION CONVENTION, JUNE 21-23, 1905.

ELECTRIC SMELTING OF ORE.

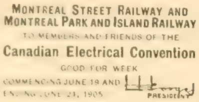
It is stated that the Dominion Government have appropriated $15,000 for the purpose of making experiments with the [illegible] process of smelting ores and manufacturing steel. The experiments will take place at Sault Ste. Marie and the Consolidated Lake Superior Power Company will furnish the necessary building and dynamos. The proposed erection of an experimental plant is doubtless the outcome of the investigations of the Commission headed by Dr. Haanel, Superintendent of Mines, which was sent to Europe last year.

C. E. A. CONVENTION NOTES.

The local committee earned the gratitude of everyone present for the splendid arrangements made for the convention.

Allis-Chalmers-Bullock, Limited, were again prominent by their daily register, of which there were four issues. The identity of any person could be ascertained by comparing the number on the white button worn with the register.

Free transportation was furnished to delegates by the Montreal Street Railway Company over the city lines and those of the Park and Island Railway. Each person was furnished with a book of fifty tickets, which was found to be a most convenient arrangement. The ticket is reproduced below:



MONTREAL STREET RAILWAY AND
MONTREAL PARK AND ISLAND RAILWAY
TO MEMBERS AND FRIENDS OF THE
Canadian Electrical Convention
GOOD FOR WEEK
COMMENCING JUNE 19 AND
ENDING JUNE 24, 1905
PRESIDENT

Thursday afternoon at the Allis-Chalmers-Bullock works was a very pleasant time. Special cars carried the party to Lachine, where the company extended hospitality in the shape of a very appetizing luncheon. A large marquee had been erected on the lawn outside the general offices of the company, and here over two hundred sat down to tastefully arranged tables. The president, Mr. K. B. Thornton, expressed the satisfaction of the association in accepting the hospitality of the company, to which Mr. George Bullock, president, and Mr. H. H. Henshaw, the general manager, replied in appropriate terms.

Mr. R. B. Hamilton, of the Packard Company, drove to the Bullock works an automobile party consisting of Messrs. A. L. Doremus, New York, Sheldon Cary, Cleveland, A. P. Doddridge, Quebec, Louis W. Pratt, Brantford, R. S. Kelsch, E. Irving, J. P. Kearney and George C. Rough.

The delegates were greatly interested in the sub-station of the Shawinigan Water and Power Company at Maisonneuve. In this terminal station there are one 8,000 h.p. frequency changer, five 1,200 h.p. frequency changers, two 900 k. w. 3-phase transformers, and two 800 k.w. rotary converters, all installed by Allis-Chalmers-Bullock, Limited. The 8,000 h.p. frequency changer was carefully inspected by the visitors, for it is not only the largest frequency changer ever built, but is composed of the largest alternating current generator in operation at the present time, viz., 5,750 k.w., and the largest electric motor ever built, viz., 8,000 h.p.

The Long Distance Hylo and Wynking Signs shown by the Packard Electric Company at the Convention represent opposite extremes; the one is a device for the lazy man, the other is intended for the hustler.

One of the novel features of the Convention was the "Wynking" signs used by the Packard Electric Company to inform everyone of the location of the Packard Headquarters in Room No. 30, Windsor Hotel. These signs consisted of circular frames studded with incandescent lamps which automatically flashed about once a second, and holding attractive cards announcing the location of headquarters for

"PACKARD LAMPS"
"PACKARD TYPE "G" METERS"
"PACKARD TYPE "R" TRANSFORMERS"
"JANDUS GOLD MEDAL ARC LAMPS"
"CROCKER-WHEELER APPARATUS"

These signs were hung in conspicuous places about the rotunda and corridors, and continually attracted a great deal of attention by their novelty. In Room No. 30 the Packard Company made a very interesting display of some of their newest features in transformer and meter design and manufacture; there were coils and sections of transformer coils showing the perfection of insulation obtained by the vacuum process with a compound of high insulating quality insoluble in oil. Specimens of the new moulded mica insulation recently developed by the Company for their Type "R" transformer were also examined with great interest by the many visitors. A new type of switchboard transformer was also exhibited, together with a switchboard type "G" recording wattmeter with glass cover. On a frame near by were Jandus multiple and series alternating arc lamps, and Mr. Sheldon Cary, of the Jandus Electric Company, Cleveland, who was present at the Convention, was kept busy in explaining their many good features to those interested in arc lamps.

Mr. A. L. Doremus, vice-president of the Crocker-Wheeler Company, for whom the Packard Electric Company are handling the sale of direct and alternating current apparatus in Canada, was also present. The Packard Electric Company itself was represented by Messrs. R. B. Hamilton, managing-director, George C. Rough, manager sales department, and J. Warren, acting manager eastern office.

The Canadian Westinghouse Company, Limited, Hamilton, Ont., had a neat and attractive exhibit of electrical apparatus and appliances. Their headquarters were in Room No. 4 of the Hotel Windsor. Distributed at various places in the hotel were reproductions of the company's trade mark formed by electric light combinations. The company had on exhibition a line of their induction motors, direct current motors, OD transformers, series and multiple AC arc lamps, meters, lightning arresters, fuse blocks, portable testing instruments, etc. Distribution was made of a complete line of the company's literature illustrating and describing their products. A striking souvenir folder, prepared for the occasion, was given out to all the attendants at the convention.

A number of souvenirs were distributed at the Convention. Mr. E. Irving, manager of the Sunbeam Incandescent Lamp Company of Canada, handed to each person a purse with a combination lock, having on one side the inscription, "You can save money by using Sunbeam Lamps." Mr. Irving will be pleased to send one of these purses to any member of the Association who did not attend the Convention.

Messrs. J. A. Dawson & Company, 743 Craig street, Montreal, distributed a neat card counter, which served to remind the recipient that they are always in a position to supply railway, electrical and mill supplies.

Conduits Company, Limited, successors to the Richmondt Conduit and Manufacturing Company, Toronto, presented the delegates with a useful souvenir in the form of a match safe, the front of which contained the name of the company and of their well-known products, "Galvaduct" and "Loricated" conduits for interior construction. On the reverse side is a useful table of decimal equivalents, an invaluable aid to the electrician.

The Sayer Electric Company, Montreal, distributed a brush bearing the inscription, "The Sayer Electric Company, Montreal, Canada—Everything Electrical." Souvenirs were also distributed by the American Circular Loom Company, D. Sleeth, Montreal, and others.

BOILER INSPECTION IN MONTREAL.

Boiler Inspector Champagne, of Montreal, has recently made his report on the operations of his department last year, in which he deals briefly with the smoke nuisance. Upon this subject the report declares that towards the end of last year there were fewer complaints about smoke, owing to the increasing number of manufacturers who are doing all that is possible to decrease the nuisance.

The visits of inspection alone averaged five a day, the total being 1,541. There were besides 203 special visits and 787 hydraulic tests. From these inspections and tests 11 boilers were condemned as unsafe, and 133 found to be imperfect in construction. The orders of the department were evidently carried out as regards safety, as no accidents are reported from this source.

During the year the licenses issued by the department were 548, and 97 other applications were rejected.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Ques. No 1.—Just as our June issue was being mailed to subscribers, a communication reached this office, which read as follows: "I have never attended a Convention of the Electrical Association, and would like to know if you think it would be worth my while to go to Montreal? I don't think the above question really belongs to your 'Question and Answer Department', and if not you needn't bother with it. However, if you can advise me some other way, I will be very much obliged."

The "Question and Answer Department" of this paper was formed with the idea of bringing the Canadian Electrical News into close personal touch with its many subscribers, and in this it has been particularly successful. While the object of the department was to deal with technical questions, we have not overlooked the primary intention, namely, to be of real use to our numerous friends. Therefore on receipt of the above letter, we immediately replied as follows: —

"Your letter reached us just too late for insertion in our June number, and we are therefore answering you direct. While the 'Question and Answer Department' is supposed to deal with technical problems only, we are only too glad to give information on other subjects which will be of value or assistance to our subscribers.

"From time to time it has been said that as all the papers and proceedings of the Convention are published in pamphlet form, shortly after the Association adjourns, it was hardly worth while for a man to go to the expense and possible inconvenience of attending a Convention in person. This, to say the least, is a very narrow minded policy. If one sit down and think carefully over the science of electricity, it seems really as if the impossible had been accomplished. Here we are dealing with a thing whose real nature we know nothing of, but in spite of this apparently insurmountable difficulty, the science has made, within an incredibly short time, the most enormous strides. Each year sees some further advance, some new improvement, or some invention which changes materially some essential feature of the art. Twenty years ago it was said that all that could be known of electricity was then known, and that the science had reached a dead wall and was at a standstill. Years later the same remark was made, but the boldness of the first sweeping assertion was lacking. Nowadays, we look upon ourselves as having accomplished wonders, but instead of being pessimistic about the future, we are exceedingly sanguine, and while we do not know just what is going to happen next, we rather expect that very shortly some momentous change will take place. Considering the fact, before stated, that we do not know with what we are dealing, we must look for some peculiar condition to explain our progress. It can be given in a nutshell. Among the members of the electrical profession, there always has been the fullest possible co-operation; this co-operation exists to-day, and always will exist. That is the whole secret.

"Therefore, our answer to your question is, Go to Montreal, and co-operate with your fellow members. Let everyone do this, and he makes himself an appreciable unit in the advancement of the science.

"Incidentally we hope that you will enjoy yourself, and we think you will consider that the trip was very much worth while."

The above was written before the Convention, and we think that the results have more than justified the advice given to our correspondent. We saw him in Montreal and he told us frankly that our reasoning was sound, and that next year would see him at the Convention in Niagara Falls, and all following years at such points as were selected. He has seen an example of co-operation, and he thoroughly appreciates the necessity.

The above, as before mentioned, is really outside the scope of this department, but we have made an exception in this case, and we stand quite ready to do so again where circumstances permit us to be of real value to our readers.

Ques. No. 2. — On my boiler here I am carrying a steam pressure of 80 pounds, and want to know if it would be more economical to increase the pressure to 100 pounds. Will it take more coal to make steam at 100 pounds, and how will the steam consumption of the engine be affected?

Ans.—You will certainly get a greater economy by increasing the steam presssure, but before doing so, we would advise you to make sure that your boiler is able to carry the increased pressure, and that your steam piping is in the required condition, and that the engine is capable of standing the increased strains which will be put upon it. So far as the boiler is concerned, the company which carries your boiler insurance will advise on this point. Regarding the engine, the manufacturer will no doubt give you the desired information upon request. Considering the boiler end only, the higher the steam pressure, the greater the capacity of the boiler, and the more economical its operation. To evaporate 500 pounds of water per hour at a pressure of 100 pounds, will of course take more coal than if the evaporation takes place at 80 pounds. Here the increase of pressure is 25%, but the increase in coal will be but little over 1/2 of 1%. This is the theoretical increase, and is based on a feed water temperature of 125° F., the factors of evaporation at this temperature being for 80 pounds 1.1262, and 100 pounds 1.1306. From the above you will see that with a very little increase in coal, the pressure can be raised considerably. With your engine, if the load and speed be constant, then to do the work a definite mean effective pressure will be required on the piston. This pressure will be constant, irrespective of change of initial or boiler pressure. If with an initial pressure of 80 pounds, you get a mean effective prsssure of 30 pounds, the engine cutting off at one-quarter stroke, then when the initial is increased to 100 pounds, the cut off will have to be shortened to give the same effective pressure in the cylinder. During the time when the valve of the engine is open, the steam pressure in the cyclinder is the same as in the boiler, less the loss which takes place in the piping. If the engine cut off at one quarter stroke, then the steam at boiler pressure will fill the ports of the engine and one quarter of the cylinder, per stroke. With an increased initial pressure, the cut off will be shortened as before mentioned, and consequently the combined area of ports and the less than one-quarter of the cylinder will be filled with steam at the increased pressure. Thus, with increased pressure, the quantity or volume of steam used will be less, but this can be calculated only if the area of the ports, clearance, etc., be known. If we assume that the area filled with steam at 100 pounds be 10% less than that when 80 pounds is used, then the engine with the higher pressure will use 10% less steam. However, the coal consumption has been increased ½ of 1%, and therefore, by raising the pressure from 80 to 100 pounds the coal consumption will be reduced 9½%. This is the approximate theoretical reduction of course, taking into consideration the conditions named above. In practice this full result may not be obtained, but certainly, if the apparatus will stand it, the increase in pressure is worth while.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope o this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

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Canadian Electrical Association. The Fifteenth Convention of this Association held in Montreal last month must be considered to have been in many important particulars the best meeting in the history of the organization. The register shows the attendance to have numbered 326. Making a fair allowance for visitors not on the membership list, this record shows a gain in attendance of one hundred above any previous Convention. It is also gratifying to note that the attentance included persons residing as far east as Halifax and west to Sudbury, Port Arthur and Fort William. This, with the invitation extended by the Halifax Board of Trade asking that a Convention be held in the Eastern Provinces, and the statement of a Winnipeg member that next year an invitation would probably be presented for a Convention in the west, may be taken as an indication of a widening interest in the Association.

The Montreal meeting was essentially a business Convention. There were more papers than usual on the programme, and the subjects were of a character to especially interest the owners and operators of central stations, of whom there were present a larger number than usual. Not only were all the papers interesting and highly instructive in themselves, but they evoked discussions which were probably quite as valuable. It is safe to say that it would have paid the owners of electric light and power stations of even average capacity to have sent a representative to this Convention. The information to be gained from the reading and discussion of the papers, as well as from mingling and comparing notes with many others in the same line of business, would have amply repaid the cost of the trip. It is learned that some central station superintendents were absent from this meeting because the companies with which they are connected were not willing to pay their expenses, and they did not feel that they could afford to pay them themselves. This is undoubtedly mistaken policy on the part of the companies and one which we hope to see changed as regards the future. The rooms of the Canadian Society of Civil Engineers, kindly placed at the disposal of the Association, proved an ideal place for the business sessions, and resulted in improved attendance and closer attention by the members to the proceedings. With the exception of one afternoon and evening, the time of the Convention was entirley devoted to business. This policy of subordinating the entertainment features to the business for which the Conventions are called together, is generally recognized as the one which should prevail for the future and best promote the welfare of the Association.

In view of the interest attaching to the extensive power development works at Niagara Falls, which works will, a year hence, be well advanced towards completion, it was the wish of the majority of the members that the next Convention be held at that point. It is felt, however, that, if possible, in the near future the influence of the Association should be extended by the holding of Conventions in the Maritime Provinces and also in Western Canada. The Association has selected a strong Executive under whose managment its affairs during the coming year are certain to be wisely managed.

Canadian Electrical Association

Proceedings of the Fifteenth Annual Convention

THE Fifteenth Annual Convention of the Canadian Electrical Association was held in the rooms of the Canadian Society of Civil Engineers, in the City of Montreal, on Wednesday, Thursday and Friday, the 21st, 22nd and 23rd of June, 1905.

At 11 o'clock a.m. on Wednesday the President, Mr. K. B. Thornton, of Montreal, took the chair, and called the Convention to order.

The following persons were registered as being in attendance :

A

C. H. Abbott, St. John, N.B., R.E.T. Pringle Co.
W. P. Ambos, New York, Osborne Flexible Conduit Co.
Thos. A. Aiton, New York, Aiton Machine Co.
W. M. Andrew, Montreal, Canadian Westinghouse Co.
M. K. Adams, Montreal, Crescent Electric Co.

B

R. G. Black, Toronto, Supt. Toronto Electric Light Co.
H. D. Bayne, Montreal, Canadian Westinghouse Co.
H. A. Burson, Montreal, Allis-Chalmers-Bullock, Ltd.
W. Bradshaw, Pittsburg, Westinghouse Electric & Manufacturing Co.
C. W. Bongard, Toronto, C. W. Bongard & Co.
E. M. Breed, Montreal, Canadian Westinghouse Co.
R. E. Brandeis, Montreal, G. M. West, Contractor.
Alex. Barrie, Montreal, The Wire & Cable Co.
George Bullock, Montreal, Allis-Chalmers-Bullock, Ltd.
T. H. Bibber, New York, American Circular Loom Co.
N. S. Braden, Hamilton, Canadian Westinghouse Co.
Wm. A. Bucke, Toronto, Canadian General Electric Co.
E. D. Brand, Berlin, Berlin Electric Co.
F. E. Barbour, Montreal, New York Central Railway.
D. E. Blair, Montreal Street Railway.
D. P. Burke, Ottawa & Hull Power & Mfg. Co.
Lewis Burran, Quebec, Quebec Railway, Light & Power Co.
T. Beecroft, Barrie, Ont., Barrie Electric Light Plant.
A. F. Byrd, Montreal Street Railway.
G. Boyer, Montreal Street Railway.
Acton Burrows, Toronto, "Railway and Shipping World."
W. D. Bird, Montreal, Montreal Light, Heat & Power Co.
F. Jno. Bell, Montreal, Canadian General Electric Co.
R. H. Balfour, Montreal Light, Heat & Power Co.
H. E. Blatch, Montreal, Canadian Westinghouse Co.
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J. A. Burns, Montreal, Munderloh & Co.
E. J. Bengough, Toronto, "Canadian Engineer."
V. Boyd, Toronto, Canadian General Electric Co.
F. B. Brown, Montreal, Ross & Holgate.
H. G. Bower, New York.
Geo. A. Brebner, Schenectady, N.Y.
J. W. Blanchet, Montreal, St. Cesaire Hydraulic Co.
Geo. C. Burnham, Montreal, Allis-Chalmers-Bullock, Ltd.
Mr. Bastien, Montreal.

C

Alfred Collyer, Montreal, Allis-Chalmers-Bullock, Ltd.
James J. Campbell, jr., Montreal, Canadian Westinghouse Co.
J. Cahill, "Montreal Herald."
Fred Chowen, Stratford, Stratford Gas & Electric Co.
Sheldon Cary, Cleveland, Ohio, Jandus Electric Co.
J. W. Campbell, Toronto, Canadian General Electric Co.
John Cochrane, Berlin, Ont., Berlin Electric Light Co.
H. J. Chapman, Montreal Street Railway.
T. W. Casey, Montreal Street Railway.
F. A. Chisholm, St. Johns, P.Q., St. Johns Electric Light Co.
E. Craig, Montreal.
Geo. S. Chester, Pittsburg, Pa., Westinghouse Electric & Manufacturing Co.
S. T. Calloway, Montreal, Locomotive & Machine Co.
E. R. Carrington, Montreal, Shiel Detective Co.
H. M. Campbell, Montreal.
E. Camp, Montreal, W. J. O'Leary Co.
Jno. M. Cox, Montreal Light, Heat & Power Co.
S. B. Condit, jr., Boston, Mass., Conduits Co., Ltd.
L. A. Casgrain, mgr. Chicoutimi Electric Co.
A. J. Carroll, Montreal, E. F. Phillips Electrical Works.
C. W. Cliff, Montreal, MacLean Publishing Co.
Norman M. Campbell, Montreal, Canadian Rand Drill Co.
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D

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H. B. Douglas, Montreal, Canadian White Co.
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Robert A. Ross, Montreal, Ross & Holgate.
Lacasse Rosseau, Montreal, Canadian Electric Co.

S

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Geo. W. Sadler, Montreal, Sadler & Haworth.
E. A. Seath, Montreal, John Forman.
E. Steinler, New York.
Thos. Sadler, Fenelon Falls, Ont., Lindsay Light, Heat and Power Co.
E. D. Sifton, London, Ont., The Electrical Construction Co. of London, Ltd.

T

K. B. Thornton, Montreal Light, Heat & Power Co.
F. Thomson, Montreal, Fred Thomson & Co.
J. A. Thibodeau, Pembroke Electric Light Co.
David Trainor, New York, Canadian Copper Co.
H. G. Taylor, Montreal Street Railway Co.
L. Trudeau, Montreal Street Railway Co.
C. Thomson, Montreal, Fred Thomson & Co.
George Teroux, Montreal.
J. P. Thomson, Toronto, E. F. Phillips Electrical Works.

V

Frank P. Vaughan, St. John, N.B., Electrical Engineer.

W

A. A. Wright, M.P., Renfrew, Ont., Pres. Electric Light & Power Co.
J. J. Wright, Toronto, Manager Toronto Electric Light Co.
H. Woodcock, Montreal Street Railway.
R. M. Wilson, Montreal Light, Heat & Power Co.
W. V. Warren, Montreal, Allis-Chalmers-Bullock, Ltd.
George H. Weaver, Montreal, Dominion Foundry Supply Co.
A. M. Wickens, Toronto, Canadian Casualty & Boiler Ins. Co.
John H. Webber, Toronto, Montreal Rolling Mills.
W. Williams, Sarnia, Ont., Sarnia Gas & Electric Co.
Eugene Waugh, New York, General Chemical Co.
A. E. Wilson, Montreal, John Forman.
Philip M. Walder, Montreal, The R. E. T. Pringle Co.
G. M. Wight, Montreal, The R. E. T. Pringle Co.
H. W. Weller, Montreal, Babcock & Wilcox.
Joseph Westgate, Montreal.
J. Warren, Montreal, Packard Electric Co.
W. McLea Walbank, Vice-President Montreal Light, Heat & Power Co.
D. H. Wilson, Montreal, American Locomotive & Machine Co.
C. A. Waterous, Brantford, Ont., Waterous Engine Works.
E. F. Waterhouse, Montreal.
Jos. Wood, jr., N.S. Steel & Coal Co., New Glasgow and Sydney Mines, N.S.
W. A. Walker, Montreal, Phillips Electric Co.

Y

John J. Yorke, Montreal, Chief Engineer St. Lawrence Sugar Refining Co.
Louis Yorston, Montreal Light, Heat & Power Co.

Z

R. H. Zavitz, Toronto, Allis-Chalmers-Bullock, Ltd.

The President then delivered the annual address, as follows :—

PRESIDENT'S ADDRESS.

To the Members of the Canadian Electrical Association :

Gentlemen,—It is a matter of great pleasure to me to welcome you all at the opening of the Fifteenth Annual Convention of the Association.

It is several years since the Association last met here in Montreal, and during the interval there has been so great an increase in the development of the electrical industries that you will find it both interesting and instructive to note the various changes and the great advance that has been made.

The Executive of the Association have made every effort to ensure the success of this year's Convention by securing an excellent programme of papers, and in addition our "Question Box" Editor, Mr. Dion, has been indefatigable in collecting questions and answers to matters of timely interest to the members.

It is the object of our Association to advance the interest of the Electrical Engineering profession in Canada, and to promote the general efficiency of the work done. That the object of the Association may be attained, it is necessary that high standards should be adopted, and that the combined assistance of the individual members should be received.

It is a matter of general knowledge to those who have been connected with the Association work for any length of time, that the interest taken by a large majority of members is very disheartening, and this condition of affairs will continue indefinitely unless a determined effort is made to interest a larger proportion of the membership. It is therefore desirable that a special committee be appointed at this Convention to investigate and report what steps are necessary to increase the membership of the association, and to induce a larger number of the members to contribute to the papers and discussions and also to take a greater interest in the Association's welfare.

It is the opinion of the Executive that the benefits to be derived from the general intercourse of members at the Annual Conventions have, in many instances, been dissipated by too large a preponderance of the entertainment feature. On account of this it has been decided this year to abandon the usual banquet and to reduce the number of entertainments in order to confine our attention more to the transaction of Convention business.

The Association this year is fortunately able to meet under particularly favorable circumstances, and are indebted to the courtesy of the Canadian Society of Civil Engineers for the use of their handsome and comfortable rooms. Personally, I feel sure that this kind co-operation on their part will be mutually beneficial.

In considering the reports received from the various committees, it is unnecessary for me to refer to the work done in the past by our Committee on Legislation ; it has been very properly brought to our attention year after year. This Committee has endeavoured with considerable success to protect "vested interests," but the time is coming when special vigilance will be in order and it will be necessary for the Association to liberally provide such finances as are required by the Legislation Committee to continue their good work.

I am pleased to report that there is a steady growth in membership and that all our finances are in a flourishing condition.

As previously stated, there have been many changes in electrical developments in Montreal in the last few years, and in order that we may have an opportunity of inspecting these changes our Local Committee have arranged for us to visit the various electrical sub-stations in the city on Thursday afternoon.

I feel sure that if the members who attend this Convention avail themselves of the facilities provided they will derive considerable benefit and the Convention as a whole will be a great success.

Gentlemen, I now declare the Convention open.

K. B. THORNTON, President.

The President : We will now call for the report of the Secretary.

The Secretary, Mr. C. H. Mortimer, then read his report, which was as follows :—

SECRETARY-TREASURER'S REPORT.

The Executive Committee at a meeting in November last closed up all business in connection with the Hamilton meeting of 1904, elected a number of new members, and gave preliminary consideration to arrangements for the present Convention.

It is to be regretted that, owing to the unavoidable absence of our regular stenographer, and the inefficiency of the appointed substitute, no proper record of the proceedings of last Convention was obtainable. Care will be taken to prevent the recurrence of this misfortune.

A Committee was appointed to draft a letter to the chief agents of the manufacturing companies, requesting that at future Conventions the practice of furnishing private entertainment be dispensed with. The members of the Committee were asked to make as widely known as possible the fact that this form of entertainment is to be discouraged.

It was decided to suggest to the Local Committee that this year a mid-day luncheon be substituted for the usual formal dinner.

A Committee was appointed to procure suitable papers, consisting of the President, Messrs. R. G. Black, Toronto, A. E. Evans, Quebec, and D. E. Blair, Montreal. The nine excellent papers to be presented to this meeting ars proof of the satisfactory manner in which the Committee have discharged their duty. A special effort has been made to meet the demand for papers which should be instructive to owners and managers of central stations of moderate capacity. In order to save time such of the papers as could be printed and sent to the members in advance of the meeting will be read in abstract.

The present membership of the Association is as follows: Active Members, 285; Associate Members, 126; total 411, showing a gain for the year of 36.

The suggestion has been made that, if possible, branches of the Association should be established at Winnipeg, Vancouver, B. C., and St. John, N. B., thus permitting members prevented by distance from attending the annual conventions to occasionally meet together for the consideration of matters of mutual interest. It is thought that the adoption of this plan would tend to widen interest in the Association and increase its membership and influence. If successfully carried out, it would also permit of the annual convention being occasionally held in Western Canada and the Maritime Provinces.

The receipts and disbursements for the year are as follows :—

RECEIPTS.

Cash on hand June 1st, 1904	$ 25 04	
Cash in Bank June 1st, 1904	817 61	
Refund by Mr. A. A. Dion on account of Question Box	22 06	
202 Active Members' fees	606 00	
74 Associate Members' fees at $3.00	222 00	
2 Associate Members' fees at $2.00	4 00	
		$1696 71

DISBURSEMENTS.

Stationery	6 76	
Exchange on Cheques	6 60	
Postage (including postage on Question Box and Proceedings)	42 30	
Telegrams	1 25	
Express	1 91	
6 large sign cards	4 00	
Expenses on account of Question Box, per A. A. Dion	185 00	
Badges for Executive	2 70	
Refunded to W. H. A. Fraser, over-payment of fees	3 00	
Grant to Secretary	150 00	
Assistant to Secretary	10 00	
Rubber stamp	1 25	
Balance of amount owing Donald Guthrie on account of Legislative Committee (payment of which was authorized at last convention)	126 97	
Balance of amount owing C. H. Mortimer on account of Legislative Committee (payment of which was authorized at last convention)	5 00	
Funeral Wreath	6 25	
Printing	129 68	
Stenographer	20 00	
Cash on hand June 1st, 1905	19 02	
Cash in Bank	975 02	
		$1696 71

Members in arrears for fees who have not responded to requests for payment, are urged to remit to the Secretary. Members are also requested to report promptly any change in their mailing address.

C. H. MORTIMER, Secretary-Treasurer.

Messrs. R. T. MacKeen and R. G. Black, auditors, reported that they had examined the cash book of the Association and found same correct.

Mr. Reesor : I move, seconded by Mr. Purcell, that the Secretary's report be adopted. Carried.

The Secretary : I have a report from the Legislative Committee for Ontario, which I will read in the absence of the Chairman, Mr. Hunt.

REPORT OF LEGISLATION COMMITTEE FOR ONTARIO.

Your Committee was called together on Friday, the 12th day of May last, to consider an amendment to the Conmee Clauses in the Municipal Act of Ontario respecting Electric Light, Gas and Water Works.

Mr. J. P. Downey, M.P.P., gave notice of his intention to move an amendment to the Municipal Act, and later presented a Bill in the Legislature suggesting several changes.

His Bill was considered in Committee on Tuesday, the 16th May, together with a clause in a general Bill entered by the City of Toronto, asking the Legislature to strike out of the Municipal Act all the clauses known as the Conmee Act.

Mr. J. J. Wright, of the Toronto Electric Light Company, and Mr. C. B. Hunt, of the London Electric Company, together with their respective legal advisors, represented your Association before the Municipal Committee, and succeeded in having both amendments defeated, but the Chairman, the Honorable Mr. Hanna, stated that during the next session of the Legislature the Government intended to bring down a Bill making such changes in the Conmee Clauses as they found necessary from past experience of the working of the Act.

It will be the duty of our successors to watch all legislation very carefully. Funds should be placed to the credit of this Committee to pay necessary expenses.

This year, as there were no funds at the disposal of the Committee, the two companies which Mr. Wright and Mr. Hunt represent paid all legal costs of presenting your objection to any change in the Act, when the matter was discussed in Municipal Committee, but you cannot expect them to do this again.

All of which is respectfully submitted.

Chas. B. Hunt,
Chairman of Committee.

The President: In accordance with Article XXI of our constitution I now appoint Mr. Black, Mr. J. J. Wright, Mr. Reesor and Mr. Evans as a special committee to strike the names for the standing committees.

Mr Reesor: I move that the committees of last year be re-appointed, and the special committee that you mention be added.

The Preident: Will anybody second that?

Mr. Evans: Some of the members of these committees may be dead.

The President: That is very true. The Secretary will read the names of the committees that we had last year.

The Secretary reads the different committees.

Mr. Black: That is how many committees now?

The President: Four.

Mr. Evans: There is one name mentioned here, Mr. President, of a gentleman who is not at present engaged in the business.

Mr. Reesor: It is only the names of the different committees that have been mentioned.

The President: Will anybody second Mr. Reesor's motion?

Mr. Black: I second it.

Mr. Black: Before we proceed, Mr. President, I wish to draw attention to a matter referred to in your address, that is, the lack of interest taken by some members in the Association, and I think it would be a good suggestion if the members present here would take extra copies of the papers, and also of the Question Box, and make a point of mailing them to friends who they know should be interested in the Association, and get a definite expression of opinion from them as to why they do not join. The Executive Committee can do a great deal in furthering the interests of the Association but they also require the assistance of the individual members. Now, if each member would make a special point of writing to two or three friends, and get an expression of opinion from them, I think it would extend the interests of the Association very much.

Mr. J. J. Wright: I suggest, Mr. President, that some time be set apart if possible for the discussion of the questions in the Question Box. There are a large number of important matters contained in them, and I think it would be profitable if some time were set apart for their discussion.

The President: I may say personally I only saw the Question Box this morning when I came into the room, and I think the suggestion is a good one. We will try and see if we cannot map out a certain time for the discussion of the questions.

Mr. Black: We might arrange to take time to discuss the Question Box just as it is arranged on the programme, divided into two or three sections.

The President: In the meantime, I think it would be advisable, if there is no other business, that we get to work on reading papers. As there is no further business, I will now call upon Mr. M. A. Sammett to read his paper on the "Effects of Frequency and Voltage on Transformers." The paper appears elsewhere.

The President: Gentlemen, I am sure we have listened to this paper of Mr. Sammett's with the greatest interest, and I am sorry that a larger number of members were not present to hear this splendid paper. I hope there will be a general discussion on this paper, because the subject has been very exhaustively taken up and handled in a most interesting manner.

Mr. Black: Mr. Chairman, I think that the members of this Association are very much indebted to Mr. Sammett for his interesting and exhaustive paper on a subject which all station men are interested in. Members may sometimes object to having techinal papers read to them, but Mr. Sammett has treated a very difficult and complex matter in a method so that almost any person could understand it, after they have taken time to give it a little study. On glancing over the paper casually, a person may not see, just at the first glance, the practical application of this paper to the small central station man, but after they have taken time to digest it, they will find it a very valuable addition to the literature on this subject, and put in a very concise and simple manner. For example, as the load increases on a small central station, it is sometimes found necessary to increase the speed of the generator in order to maintain the voltage at the centre of distribution. A person could easily do this by changing the size of the pulley on the generator, but I question if very many of us have taken the time, or have had the ability, to wade through the books on the subject, to find out just what effect this change of frequency would have on the transformers on the lines. Another way in which it applies to small station men running 133 cycles is when he finds it necessary to increase his plant, and he is recommended to put in 60 cycles machinery. He naturally wants to know whether the 133 cycle generator can at any time be used as a reserve. He also wants to know, and it is absolutely necessary he should find out, whether he has got to scrap all his transformers, and change all his line arragements if he changes the frequency. With the electrical business, as you all know, there is a very heavy peak for say 150 hours each year, and if the old generator could be used during that time, it would keep down the plant account very materially. When we have had time to study all these curves, the central station man will be able to determine for himself just to what extent this might be advisable. Another case, where it applies to the small central station man, is when his new 60 cycle generator might burn out. He would want to know if he could use his old generator, e.i., the 133 cycle generator, or he might have a 60 cycle installation, and want to know if he could run 30 or 25 on his lines by using special taps on large station transformer. In Western Ontario, where nearly everybody expects to use Niagara power soon, it is very necessary that station men should know whether they can make a make-shift in this way, should it be necessary to do so.

Prof. Herdt: Mr. Chairman, I wish also to congratulate Mr. Sammett for his excellent paper. On the first page of this paper, Mr. Sammett states that the energy loss in Eddy current varies as the square of the thickness of the laminations of the iron. Some experiments that have been carried out quite recently tend to show that the Eddy current loss does not increase quite as rapidly as the square of thickness of iron, especially when the laminations exceed one-half a millimeter. This is probably due, although the cause is not fully ascertained, to self induction in the thickness of the pieces of iron. It is also stated that the Eddy current varies as the first power of the specific electric conductivity of the iron, that is, a transformer, when hot, will not have the same Eddy current loss as when cold. With a 50° Centigrade rise, which is of course excessive, the Eddy current loss would be approximately diminished by half. Mechanical pressure on the laminations will also effect the Eddy current loss, the Eddy current increasing with increase of pressure; Eddy current loss varying also with the mechanical treatment of the iron laminations.

Mr. Lambe: I would like to ask Mr. Sammett about the two types of transformers that are generally on the market in medium sizes for pole construction—the high frequency type and the low frequency type. Is it not true that while the high frequency type, as is often stated, will work satisfactorily on a low frequency, the lower frequency type is always the better transformer.

Mr. Sammett: In reply to Mr. Lambe's question, I would like to say that I perfectly agree with him. Transformers of a lower frequency will prove a better apparatus when used on higher frequencies. As far as temperature rise goes, the radiating surfaces being larger, the transformer will run cooler and consequently last longer than transformers of higher frequencies with same losses and smaller radiating surfaces.

The President: Mr. Leonard, have you nothing to say on the subject?

Mr. Leonard: It seems to me that the subject has been treated very exhaustively in the paper, and the little discussions have been quite to the point as well, bringing out the bearing of this paper on the work of the various central stations. I do not think that much further discussion is required on the matter.

Prof. Herdt: I should like to ask Mr. Sammett, why is it that three-phase transformers are so little used in this country. They have the advantage of a much reduced weight for equivalent capacity, and high efficiency.

Mr. Sammett: The three-phase is a more efficient transformer, a convenient transformer to handle, taking up less space in the station or at the customer's premises. So far it has been objected to only on the ground of the large expense involved in carrying a spare unit. With two or three transformers on a polyphase circuit, any trouble that might result on account of a burn out in a single transformer will be remedied by replacing this single unit, while in the case of a polyphase transformer, the equivalent of the group of transformers will be disabled, and the substitution of the polyphase apparatus would be necessary every time. If transformers were as durable as other alternating current apparatus, thus requiring a minimum number of spare units, the objection of the higher expense involved would be done away with. From a statement made by the engineer of the General Electric Company, I understand that at the present time the kilowatt capacity in polyphase transformers amounts to 30 per cent. of the total kilowatt transformer capacity manufactured at Schenectady, thus showing this type gaining a foothold in America. It is my belief that as soon as the polyphase transformer is made a durable apparatus it will become as universal as it is in the Old Country.

Mr. Higman: I would move a vote of thanks to Mr. Sammett for his very able paper. I am sure that its study will well repay those interested.

Mr. A. A. Wright: Mr. Chairman, I have been requested to second Mr. Higman's motion. It is unfortunate that I arrived so late, and had not the pleasure of listening to the paper, but I have no doubt that it is all that you have said it was, and I have no doubt that the gentleman who wrote the paper expended a great deal of valuable time in preparing it, and I have certainly great pleasure in seconding the motion. Carried.

The President: As there is nothing further on the morning programme, we will adjourn the meeting. At the afternoon session, which commences at 2 o'clock, a paper will be presented by Mr. MacKeen on "Transformers," and I hope you will all be here.

Mr. Higman: Before we adjourn, I would like to call your attention to what has apparently been an omission, that is, the reading of a communication from the Chamber of Delegates of the International Congress at St. Louis, in regard to the standardization of machinery. The subject is a very important one, and this Association has been asked to take the matter up and I hope the communication will not be ignored.

The President: In one respect you are in error, Mr. Higman, for the communication was read to the Executive Committee this morning, and they proposed to take communication of it before the completion of this session, and probably will refer it to the new Executive Committee to take it up very shortly. We had no intention of ignoring the communication. The meeting now stands adjourned.

WEDNESDAY AFTERNOON SESSION.

The convention resumed at 2.15 p.m.

The President: We have a very big afternoon, and are starting a little late. The first paper on the programme this afternoon is one by Mr. MacKeen on "Transformers," and I will now call upon Mr. MacKeen to read it.

Mr. MacKeen read his paper.

The President: I do not know whether it is the wish of the meeting, gentlemen, but this paper has taken a little longer than expected; I think perhaps it would be better if all the papers were read first, and then the general discussion take place afterwards. I think it would be only fair for the other gentlemen to read their papers now, and have the general discussion afterwards. If that is agreeable, I would now call on Mr. William Bradshaw to read his paper on "The Selection and Maintenance of Service Meters."

Mr. Bradshaw read his paper.

The President: We will now call upon Mr. Lambe to present his paper on "Incandescent Lamps."

Mr. Lambe also read his paper.

Mr. Denis: What is the usual position of placing a lamp when running it for life—horizontally?

Mr. Lambe: Life tests are usually made with sockets up above, and the lamp hanging, although you can of course run the test in different positions.

Mr. Higman: The particles of carbon discharged from the filament would be carried out spherically to the walls of the lamp no matter which way it hung.

Mr. Lambe: To tell you the truth, I have not gone into that part of it. I would imagine it would come fairly equal in all directions.

Mr. A. A. Wright: When you say "various times of the day," I suppose you mean various times of the night too?

Mr. Lambe: Yes sir.

Mr. Duncan: What is the price of the Tantalum lamp?

Mr. Lambe: They sell for $1.00 to $2.00, I think, somewhere around that, that is, in the country of production.

Mr. J. J. Wright: What is the name of the lamp?

Mr. Lambe: Tantalum. It is the metal or material of which they are made?

Mr. J. J. Wright: What do you mean by the material of which it is made?

Mr. Lambe: It is the filament that is made of Tantalum. It is one of the rare metals.

Mr. J. J. Wright: There is a question I would like to ask. What is the reason for saying that the bases should be changed, and that the manufacturers are going to make entirely Edison base lamps?

Mr. Lambe: Because it means standardization, and standardization is a benefit in very many ways. As the Edison base was considered the best of the lot for many different reasons, it will gradually come into universal use.

Mr. Higman: It is the survival of the fittest.

The President: I think you will all agree that we have had three most excellent papers this afternoon, and while I know that perhaps some of you may feel a little tired, I hope that fact will not prevent you from discussing the papers, as there is a great deal of value to be derived from a good discussion.

Mr. A. A. Wright: I have listened to the papers with a great deal of pleasure, and I want to ask a question, and that is, why is it that the Edison base is much preferable to the T. H. base? As has been said, from a manufacturers' point of view it is most desirable. That I can readily understand, but from the consumers' point of view I want to know what is the trouble with other bases than the Edison. I have been a user of both T. H. and Edison bases for about 24 years, I think, and I yet have to see any advantage in form or otherwise that the Edison base has as compared with the T. H. I would like to know what is the principal reason for this great change? I always thought that one was as good as the other, and I would just as soon have one as the other, but it is far easier to manufacture ten thousand of one kind than it is to manufacture five thousand of two different kinds, and if all manufacturers would manufacture one kind of base, then we would get a cheaper lamp. Further, I understand that it was cheaper for the manufacturer to manufacture the Edison base than it is for him to manufacture the T.H. base, and for these two reasons it was better to adopt one particular base, and the consequence is that they adopted one particular kind. It is a rather serious affair, when all your lamps and sockets are of the one kind.

The President: I think Mr. Wright has hit the nail on the head. It is the consumers who are buying the lamps, but they have absolutely no say in the matter at all. The manufacturers have decided to make a change, and we might as well accept it. In connection with the company which I am connected with, we have over three hundred thousand incandescent lamps, of which the major portion were T. H. lamps. We are changing all these lamps to Edison, and expect to have the whole thing done in two years. As soon as we decided to change we refused to take any new or renewal contracts except on the understanding that Edison lamps were to be used. The change is taking place very much more rapidly than we anticipated.

Mr. Higman: Why are you making the change, Mr. Thornton?

The President: The manufacturers have decided that the Edison lamp is to be the standard, and besides, as far as we are concerned, we are only too glad. We supply free renewals to our customers, and it is not in our interest to stock up several styles of lamps with different bases.

Mr. J. J. Wright: I have just looked over the Question Box, and there is one question, No. 57, "What is the best incandescent lamp base to adopt and why?"—the only question in the box that has a large number of answers. The question has eight answers. Seven of the eight are members of operating companies, and every one of the whole eight say Edison.

Mr. Higman: I might say that we are changing all the lamp banks of our testing offices throughout the country to the Edison base, simply because we find it to be a better and more convenient base than others. While on the subject of this paper I might say a word with reference to the photometric value of tests made of incandescent lamps. Very frequently samples of lamps are sent to Ottawa by small central stations to have their candle power value and energy consumption given, and the claims of the manufacturers of lamps are not borne out by actual tests in nine cases out of ten. Something might be said with regard to the standards used in our photometers. The Hefner lamp, of the Reischaustalt, Germany, is used in that country, the Carcel lamp in France, and the Pentane lamp by the scientific bodies in England; but the British Government, with that conservatism which has become proverbial, still clings to the old sperm candle, which has an inaccuracy anywhere up to 10%, while the oil lamps that I have mentioned can be depended upon up to about one and one-half per cent.

Mr. Sammett: Anything that I might say would be a repetition of Mr. MacKeen's remarks. The subject was treated by him broadly and thoroughly. There is one point, however, which would bear repitition, namely, the question as to whether a slightly better core loss should be sacrificed for what is to be gained in a better insulated transformer. As shown on one of the curves, the transformers of six different manufacturers give iron losses that differ but slightly, and therefore a purchaser who selects transformers on the basis of the core loss alone is likely to be misled. While the core loss is a very important consideration, the question of life of the transformer as well as safety of the high tension coils from getting in contact with the secondary winding should be borne in mind. Short life due to either poor facilities for insulating the coils, or excessive temperatures at which they operate, will make the transformer a very expensive apparatus indeed, while inadequate and insufficient insulation between the primary and secondary coils may cause loss of life or property, which is likely to result in a heavy loss to the operating company. Durability, safety and core loss should be considered in the selection of transformers.

Mr. A. A. Wright: I would like to put a question, if somebody would answer it, and that is in reference to the oil in the transformers. The oil in our transformers after a time becomes very thick, and it will not run. I want to know whether the oil will get thin, if it is heated, and whether it is necessary to remove that thickened oil or not.

The President: Mr. MacKeen, I guess you can answer that.

Mr. MacKeen: The continued heating of an oil at high temperatures tends to carbonize the oil to a greater or less extent, which causes the oil to blacken. In oil used to rupture arcs such as in oil break switches, the tendency to carbonize is more pronounced. Arcs which take place in a transformer will also effect more or less carbonization. Blackening of oil from carbonization doubtless reduces the dielectric strength to some extent, but not until the oil becomes thick and lumpy does it interfere seriously with the operation of the transformer and then more as a detriment to cooling than to insulating qualities. Then, oil may become blackened due to the absorption of soluble insulating materials used in some makes of transformers. Blackening in this case does not necessarily indicate a weakened dielectric strength, but thickening from this cause reduces the cooling qualities of the oil.

Mr. A. A. Wright: The oil would all shrink away from the top for one thing, and if the transformers were not quite full we would just give them an additional dose. I was speaking to one gentleman about it—perhaps I need not mention his name. He told me, "We just take the oil out and throw it away," and he said it was just as good without the oil as with it. (Laughter).

Mr. MacKeen: Oil slowly evaporates from transformers which are not absolutely air tight. This evaporation is perfectly natural and must be watched so that the oil does not sink below the top level of the core and coils. Fresh oil should be added to supply losses due to evaporation. Oil cooled transformers should never be operated without oil except, possibly, in cases of the greatest emergency.

Mr. Sammett: It is better to leave whatever oil there may be in the transformer and add a sufficient quantity to cover the coils completely. From my experience I find that oil improves with use and tests made on oil when in use for any length of time will invariably give a much higher result for the dielectric strength than new oil. It may be of interest to state that a test made on oil taken out from the case of a burn out transformer proved to be dielectrically much better than fresh oil. I had no occasion to repeat such tests in order to get definite information, but in this case though the results are paradoxical, they must go on record as an actual fact.

Mr. A. A. Wright: Does it make any difference what kind of oil you use? Could you use linseed oil?

Mr. MacKeen: A suitable oil for use in transformers should possess certain well defined characteristics. These are as follows: A high flashing and burning point; chemical reaction neutral; absolutely devoid of moisture; high dielectric strength, and low temperature cold test. All of these characteristics enter very largely into the selection of suitable oil by manufacturers. Oil recommended and supplied by manufacturers of transformers should always be used in preference to any other oil simply because such oils are selected by them to best fill the conditions. The characteristics above cited are found only in mineral oils, and vegetable oils should never be used. It is undesirable to use what are known as thin oils, or oils of low viscosity, because they usually have a much lower flashing point than more viscous or thick oils. The importance of having oil absolutely free from moisture can be appreciated when it is known that 1/100% of water in an oil decreases its dielectric strength nearly fifty per cent. A good oil for transformers should possess the following characteristics:

Specific Gravity	.869 – .880 at 15°C.
Flashing Point	190 to 183°C.
Burning Point	209 to 215°C.
Chemical Reaction	Neutral.
Viscosity	61 – at 100°C.
Cold Test	10°C.
Break down at short intervals,	23,000 volts.
Break down,	30,000 to 40,000 volts.

Spark gap for voltage test separated 200 mills, using 1/2" discs.

Mr. A. A. Wright: We will now shunt off onto other matters. I think that the manufacturer who sends you meters should have these meters inspected and pay the inspection just the same as the manufacturer of scales. The manufacturer who sells you scales has to give you certificates with them. Why should not the manufacturer of meters do the same thing? It may be a little selfish on our part, but still it would be only right, I think.

Mr. Higman: You pay the inspection all the same.

Mr. A. A. Wright: That is very true, but you go to your customers and say, "Here is a meter that is inspected," whereas, if you give them one that is not inspected, they sometimes think it is not the proper meter.

Mr. Higman: The Department discourages the practice of testing meters at the place of manufacture, afterwards to be shipped long distances by freight or express. A meter might be accurate when leaving the test room of the manufacturer at Peterborough or Pittsburgh and show great inaccuracy when arriving at Halifax or Vancouver. There are other objections why this practice should not prevail, and among them might be mentioned the fact that the conditions under which the meter is to be used are wholly different in some instances from those in the manufacturers' test room. I have a case in mind now where it was found impossible to bring a number of meters within the three per cent. limit of error owing to some inherent defect in the generator. On the surface everything appeared to be right. The voltage and frequency demanded by the meter were there; but there was something else that could not be seen, probably a serious distortion of wave form, which put the meters outside the limit as to accuracy. These meters, among the best on the market, will have to be recalibrated to suit the local conditions. While on my feet I would like to say a word in respect of Mr. Bradshaw's very excellent paper on electricity meters. No one, I am sure, will take objection to the list of requirements that he has laid down. It might be stated that the Department requires that every new meter, before it is placed on the market, shall be submitted to the Electrical Standards Laboratory for examination and report. The nature of the tests to which these meters are subjected may be enumerated thus: 1. A test for sensitiveness. For this test a starting current equal to two per cent. of the full load capacity is used. 2. Accuracy. Loads varying from quarter up to full load and down again. 3. A test as to the effect of the application of external magnetism. 4. A test as to the effect of variation in voltage, frequency and wave form. 5. Fall of potential in the series coil; resistance, location and energy consumption of the shunt coil. A test for durability is desirable but this cannot always be applied. Usually meters are submitted to the department with the request that we telegraph on receipt whether the meter is approved or not. In one instance a meter was before the department two years, during which time it was reconstructed throughout two or three times before it would test out correctly. Referring again to Mr. Bradshaw's paper I might say that the frequency curve shown is theoretically correct and desirable, but in practice unfortunately we find the departure from accuracy occurring at a much earlier period in the variation.

Mr. A. A. Wright: How long has that been the law, Mr. Higman, that every meter should be tested?

Mr. Higman: Since the Inspection Act was first put in force. When a new meter is approved by the Department, a circular is issued to the inspectors. The inspectors refuse to inspect a new meter until this circular is received.

The President: I am afraid it is getting a little late to take up any of the questions in the Question Box, although it is on the programme to take them up this afternoon. Is there any more discussion on these papers?

Mr. MacKeen: I would like to ask, Mr. Higman, do you insist on meters being tested at their normal rate of voltage, and do you insist on meters being tested by direct current or alternating current?

Mr. Higman: We invariably test meters under the conditions called for as to voltage and frequency. The electric lighting company provides the testing current.

Mr. A. A. Wright: I do not wish to be noted for my much speaking, but I am here for information. I would like to know where is the best place to put a meter in a house. If it is in the bedroom, and there is somebody sick in that room, and you go there to read the meter, you cannot get in and you will have to wait for another month. If you put it in a clothes room, it is so dark you cannot see to read that meter very clearly. Then, if you put your meter in an out of the way place, your man cannot get at it in case of fire. I have been thinking if down the cellar-way would not be a very good place.

Mr. Higman: The Departmental Regulations require that the meter shall be so placed that it can be conveniently read by the inspector, or by whoever wishes to read it. I do not know that the inspectors always insist on that, but I think they should.

Mr. A. A. Wright: But the question is where to put it.

Mr. Fisk: I might say we have had six or seven large fires in Peterborough in my memory, and we have only lost one meter. We have had three meters in buildings which were entirely destroyed, which came out all right.

Mr. A. A. Wright: Where do you put them?

Mr. Fisk: We try to put them in the attic if possible, right where the service wires come in. We find this a very convenient place.

The President: We insist upon meters being located at the point of entrance of the feed wires, and in such a position that they can easily be read by our meter reader. Our contract is so worded that the customer is entirely responsible for the meter on his premises in case of fire.

Mr. A. A. Wright: That is a new point for me.

The President: That is the only way to do it.

Mr. Higman: Section 5 of the Inspection Act makes the owner or contractor responsible for the proper condition of the meter and all other appliances owned by him on the consumers' premises.

The President: If you will refer to our contracts, you will see that is the way they are made, and I have known many cases where the customers have paid for damaged meters.

A Member: I would like to ask a question in regard to a point that has occurred to me in reading over the Act. It seems to read in a way that nobody but the Government may test a meter, to find out whether it is accurate or not.

Mr. Higman: A few years ago a couple of smart men came over from the other side and started a bureau in Toronto called the "Standard Meter Bureau." They succeeded in frightening the people as to the condition of their meters, saying, "We can save you hundreds — it may have been thousands — of dollars by testing your meters for you," and incidentally they charged four or five dollars for their test. We knew that that test was unnecessary, and in order to put them out of business we amended the law, which states that no one but the inspector shall test and give a certificate as to the accurateness of a meter. There can be no objection, as I understand it, to the electric lighting companies testing their meters as often as they please, provided they do not break the seal. They can test it in situ without breaking the seal, but if the meter is removed and the seal broken, then a new test by the inspector must be made before it can be fixed for use again.

Mr. Bradshaw: Do you allow removal of the meter at all. Many companies have no provision for testing on the premises. Are they allowed to take them to their laboratory for test, if the seals are not broken?

Mr. Higman: Yes, so long as the seal is not broken.

Mr. Lambe: The act says "every person." That means that even the owner of the meter, as I read it, has no right to test that meter.

Mr. Higman: The construction would be as to what constituted a test. The definition might have been a little better. It was never intended that it should prevent the company from ascertaining the condition of its meters.

Mr. A. A. Wright: I might say that I was in the House at the time this law was amended, and I voted for it, because I thought it was a good thing. As Mr. Higman has just said, if these people came to the large cities and went around to our customers, and told them that their meters were all wrong, and that they were being swindled out of so much money, they would cause all our customers to be affected with the fear that the meters were wrong, and that they were being cheated, and that the electric light men were a lot of swindlers.

Mr. Lambe: Another curious point that I have noticed is that the Act says, "Within 12 months after the expiration of five years." This means, does it not, that the meter has to be inspected only every six years?

Mr. Higman: We could not, of course, say exactly five years. There has got to be some leeway for the bringing in of the meters. If you said five years, legally you could be tied down to the very day. Manifestly, you could not do that.

Mr. Fisk: It is a very good thing.

Mr. Higman: We might have said within two months, or some such time, but we thought that one year would be less onerous on the companies.

Mr. Lambe: Why?

Mr. Higman: An interim test may be made at any time either by the company or by the consumer, a test for which only fifty cents is charged, irrespective of the capacity of the meter, so that every facility is offered in that respect.

Mr. Fisk: I don't believe that a company could keep out a meter for five years.

Mr. Wright: I believe you are right, too.

Mr. Higman: Well, we thought it preferable to put the electric meter on the same basis as the gas meter, which is five years.

Mr. A. A. Wright: Well then, you reinspect any time before that for fifty cents.

Mr. Higman: Any time.

Mr. A. A. Wright: We will have all our meters tested after they have been out for four years and eleven months for fifty cents each.

Mr Higman: Meters are now systematically cleaned and tested by the companies before they are submitted to the Government officers for inspection, and I think the Department may reasonably claim some credit for this improved condition of affairs. During the first year of the inspection more than 50 per cent. of the meters were rejected as being inaccurate. Meters as manufactured to-day are fairly dust-proof and many of the types will stand up against a five years' run, but at 50 cents for each test they can be taken down every week if necessary.

Mr. Bradshaw: I don't believe that anyone ought to leave a meter out five years. I do not care how good it is, it would be better to pay his fifty cents and have it attended to before that time. The best companies in the States, using various makes of meters, rarely let them run over a year's time, and he ought to have his department fixed so that he could test them every year. In the end you will save money by having a systematic test in some simple way, which will tell you how the meter is.

The President: I think that is the practice with some of the large companies in Canada that I know of. It would be almost impossible to test all your meters in one year, unless one had a very large staff, which would increase the operating expenses very considerably. We watch the behavior of our meters in a good many ways. We endeavor to have an annual inspection of all customers' premises once a year. While inspecting the premises, the inspector checks up the meter, and, in addition, our billing department analyses the readings as taken by the meter readers, and the very instant there is any disrcrepancy in readings, that meter is checked up right off. If there is any doubt the meter is taken down and tested. The meter readers are also instructed to test doubtful meters by turning on a light.

Mr. A. A. Wright: I would just like to ask Mr. Bradshaw how they do. Our way is this: I send a man around with a five candle power lamp. We take off the lamp and put on the five c.p., and if it starts on five c.p., we take it for granted it is all right. Now, is there any better way than that?

Mr. Higman: I might say that an employee of one of the electric companies informed the Minister of our Department that he had a scheme whereby he could make the meters go fast or slow without going near them, and as I understand it, challenged the Department to find out just what it was. I am aware that by reducing the speed of the generator and consequently the frequency, alternating current meters can be made to go fast. In doing this the machine would have to be over excited in order to maintain the voltage. I do not think, however, that companies would resort to such an expediency to defraud the consumer. Notwithstanding, I think it may be necessary for the Department to regulate the variation of frequency in the same way as the electrical pressure is now regulated. I would like to avail myself of the present opportunity of saying a word to the manufacturing companies, and it is that the Department will require them to supply with their meters more exact information in respect of their characteristics. It is necessary that they should fix in some conspicuous place on the meter cover a small plate on which should be legibly stamped or engraved the following information: (a) the manufacturers' shop number; (b) the amperes; (c) the volts; (d) the frequency in cycles; (e) the number of revolutions per minute of the rotating disc when the meter is working under full load. I am aware that the volts and amperes are usually given on the dial plates of most meters; the frequency is pasted on the back of some and the rotating constant is usually contained in a pamphlet that cannot always be found when needed and often involved in an equation that is not easily understood by those immediately concerned. The information I have outlined can be put into a small space and it is all the information that is needed to make an intelligent test of the meter.

Mr. Fisk: In regard to that variation of frequency, I think this must have been a very small plant.

Mr. A. A. Wright: And a small man, too.

The President: I know in our company we must have our frequency absolutely constant, and have apparatus to show us that it is so, so that if the meters are tested for frequency we never have any trouble.

Mr. A. A. Wright: I would like to have an answer to that question with reference to the testing of the meters.

Mr. Bradshaw: Of course, that gives you an indication of whether the meter will actually run or not. A lamp 20 watts, that is a good light to test it on, but that is no test as to the accuracy of the meters. It might be 20 or 25, and one would not know whether it was or not if you did not have an instrument to check it. One way is to take some form of integrating standard, which is pretty generally in use all over the States now, and meters are being made specially for that purpose, with two or three series coils, so that any meter will contain in itself different capacities for all meters that the central station would have, and a man can make a test on the meters in service almost as quick as he can make the inspection. I know of at least three big companies, one in Pittsburg, one in New York, and the other in the west, where they are using that method entirely, and the manufacturers are now coming to that point that they are making these special meters for high power wörk, and it seems to be the cheapest and most reliable method for full service.

Mr. Fisk: In our company we have a very good scheme. We have incandescent lamps of different candle power on a board which can easily be carried around. This small bank of lamps is checked up with a standard watt meter at the office, on different voltages. This with a volt meter and stop-watch makes a very good outfit for portable work.

Mr. Bradshaw: This method is in use in a good many states, too.

Mr. Leonard: I would like to move a very hearty vote of thanks to Mr. R. T. Mackeen, Mr. William Bradshaw, and Mr. A. B. Lambe, the authors of the three interesting and very able papers read to us this afternoon. Carried.

The Convention then adjourned until the following morning.

SECOND DAY.

The Convention resumed at 11 a.m.

The President: It is absolutely necessary, in order that the programme may be carried out as arranged, that we get through in time to be over at the Windsor Hotel by 12.45. Unless this is done, we cannot complete our programme. I hope that the balance of the members will come in as the morning proceeds. Mr. Higman yesterday referred to a resolution of the International Electrical Congress. I will now read his letter.

Ottawa, April 28th, 1905.

Secretary Canadian Electrical Association, Toronto.

Dear Sir: In accordance with a resolution adopted by the International Electrical Congress at St. Louis in September of last year, I have the honor to submit for the information of the Canadian Electrical Association copy of a resolution adopted by the Congress in relation to the International standardization of the nomenclature and ratings of electrical apparatus and machinery.

I shall be pleased to receive at an early date the views of the Executive of your Association with regard to the proposal; and whether in the event of the formation of an International Electrical Congress your Association will be prepared to appoint a representative for Canada.

It will be observed by reference to the "Proceedings" that this Congress relates to the standardization of electrical machinery and not to electrical units of measure. The Congress on the latter subject will be composed of delegates appointed by the various governments.

Awaiting your earliest reply, I remain, Sir,
Your obedient servant,
O. HIGMAN,
Delegate of the Government of Canada.

RESOLUTION OF CHAMBER OF COMMERCE.

The following report was received and unanimously adopted from the committee on international standardization:

"The committee of the Chamber of Delegates on the standardization of machinery begs to report as follows:

"That steps should be taken to secure the cooperation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardization of the nomenclature and ratings of electrical apparatus and machinery.

"If the above recommendation meets the approval of the Chamber of Delegates, it is suggested by your committee that much of the work could be accomplished by correspondence in the first instance, and by the appointment of a general secretary to preserve the records and crystallize the points of disagreement, if any, which may arise between the methods in vogue in the different countries interested.

"It is hoped that if the recommendation of the Chamber of Delegates be adopted, the commission may eventually become a permanent one."

Mr. J. J. Wright: Mr. President, I move that the communication be referred to the new Executive, to take action in the matter.

Mr. Higman: Before this motion is passed, I would like to call attention to the resolution. I may say that the matter was primarily taken up by Col. Crompton, of London. He has for some years been collecting data on the subject, and has spent several thousand pounds, he tells me, of his own money in forwarding the project. The Congress at St. Louis decided to second his efforts in that respect, and the following resolution was passed in the Chamber of Delegates: "That the delegates report the resolution of the chamber as to international standardization to their respective technichal societies, with the request that the societies take such action as may seem best to give effect to the resolution, and that the delegates be requested to communicate the result of such action to Col. R. E. B. Crompton, Chelmsford, England, and to the president of the American Institute of Electrical Engineers, New York City." As will be seen, the submitting of this resolution to the technical societies of Canada devolved upon me, and I may say that the Canadian Society of Civil Engineers have notified me that they are in perfect accord with the aims of Col. Crompton and the proposed international commission. It will, however, devolve on this Association to select the delegate to represent Canada on the commission. As the commission is to deal with the standardization and rating of electrical machinery, the choice of a delegate will necessarily have to be made from among the manufacturers or consulting electrical engineers, and I have no doubt that the Council of the Association, or the Executive, will be able to meet the requirements of the case. When the delegate has been chosen, and reported by me, my duties in regard to the matter will have ended.

Mr. A. A. Wright: Mr. Chairman, I have much pleasure in seconding that resolution.

The President: It has been moved by Mr. J. J. Wright and seconded by Mr. A. A. Wright that this matter be referred to the Executive. Is that the wish of the meeting? Carried.

The President: The first paper on our programme is one by Mr. A. L. Mudge entitled "The Operation of Alternators in Parallel." I am extremely sorry that Mr. Mudge is not able to be here himself. As I did not arrange to get any person to read the paper, I am obliged to read it myself.

The President: It is most unfortunate for us that Mr. Mudge was not here to read the abstract of his paper himself, as he could have dilated upon the little points that have come out in his paper as he went along. I personally have not had the time to read through or thoroughly digest this paper, and I am sorry. as I am therefore unable to do full justice to it, but the points mentioned are well known to all station operating men, and as there are a good many station operating men here who are familiar with the points raised, I hope that we will now hear a few words from some of them. I think it is advisable to have the discussion immediately after the papers are read. We tried the method of reading all the papers first, and having the general discussion afterwards, yesterday afternoon, and it was not a success; so if there is going to be any discussion, I would ask the members to rise promptly and discuss the papers, in order that we may carry out our programme in due time.

The President: Have you anything to say, Mr. Burson?

Mr. Burson: With regard to synchronous motors, they are the most satisfactory drive for operation of generators in parallel, such as the Shawinigan station. That type gives a speed absolutely constant. With an induction motor speed depends naturally upon slip, and the slip depends on the resistance of your rotor. Hence it is a very hard thing to make two machines exactly alike as regards full load speed. If you can get your two induction motors to have the same slip at full load, and you operate them both at full load, then your two A. C. generators will be driven at the same speed, and will have the same frequency. But the operation is not as satisfactory as with the synchronous motors. As regards the motor being two or three phase, it makes no difference in operation.

Mr. Lambe: I would like to ask if three phase motors give a more uniform drive than two phase, also if the angular velocity of a three cylinder engine is more uniform than the angular velocity of a two cylinder engine as applied to parallel operation of alternators.

Mr. Black : On various occasions I have required to look into the matter of parallel operation, and I think I am in a position to answer Mr. Lambe's question. The angular velocity of the three cylinder engine is practically the same as the two cylinder engine, i. e., cranks set at 120 degrees and cranks set at 90 degrees give practically the same results as far as the parallel operation of A. C. machines is concerned. With reference to the synchronous motors driving A. C. generators, and also induction motors driving A. C. generators, several interesting problems come up. When you use a synchronous motor or induction motor to drive an A. C. generator there is generally a difference in frequency, that is, you have 25 or 30 cycles, and you require to change to 60 cycles. Where you have 30 cycles there is no difficulty in paralleling on the 30 cycle end and also on the 60 cycle end, as you have just halt the number of poles on the motor that you have on the 60 cycle generator. When you have 25 cycles and wish to change it to 60 cycles it is a little more difficult, as 25 and 60 are not multiples of each other. Hence great care has to be used in selecting the proper number of poles on both motor and generator. This was first noticed, I believe, in the Buffalo sub-station supplied with 25 cycle current from Niagara Falls. The synchronous motor had eight poles and the 60 cycle generator had 20 poles. It was found that when the motors were put in parallel that some times it was impossible to parallel the 60 cycle end. Upon investigation it was found that there were just four points at which both the 25 cycle end and the 60 cycle end of the units could be paralleled. With other combinations of poles it becomes more difficult to parallel. Another interesting problem which comes up when using synchronous motor frequency changers which Mr. Burson might have told us about when he referred to the frequency changing sets at the Shawinigan substation, which we hope to have the pleasure of seeing in operation this afternoon, is the difficulty of making the last unit put on the bus bars take its share of the load. As the switching in and dividing the load on an A. C. generator driven by a synchronous motor has to be treated differently than a unit driven by an engine or water wheel, the operation in multiple of frequency changers driven by synchronous motors is of considerable interest. Imagine an A. C. generator driven by a synchronous motor to be in operation and a second unit to be connected in parallel with the first. Imagine that the first set is carrying full load and that the second set is to divide the load with it. The motor end of the unit can be parallel in the usual manner by adjusting the full current so that the potential difference between the bus bars and the synchronous motor vanishes and then closing the switch connecting it with the bus bars the instant they are in step. If the generator end of the set is synchronized in the same way it is not possible to make it take any load. If the field current of the 60 cycle generator end is diminished or increased the load on the frequency changer remains unaltered, and the effect of changing the excitation results only in an increase of the cross currents between the two sets. Now, in order to make the second set divide the load with the first, it becomes necessary to abandon the usual method of paralleling and to do so in the following manner : First parallel on the motor end in the usual way and then when paralleling on the generator end of the set make the field current of the new unit the same as on the loaded unit. Then when they are in step close the switch connecting the second unit on the bus bars and the machines will divide their load. It is necessary, of course, that the machines have the same characteristics. Any person who is interested in this particular case of parallel operation will find a good article by Dr. B. A. Behrend in the Electrical World, February 13, 1904. With reference to the parallel operation of A. C. generators driven by induction motors, there are also a few points which require attention, as the method is different from the usual procedure when engines or water wheels supply the motive power. For example, suppose you have an A. C. generator driven by an induction motor fully loaded and as your load is increasing you wish to put another machine on the bus bar. Suppose the load came up quickly and there is a heavy overload on, then your speed will be say 4% below synchronism. When you start up your new set, also driven by an induction motor, it will run at synchronous speed, as all induction motors run at synchronous speed when not loaded. It will therefore be necessary for you to open the switch on the induction motor and parallel on the 60 cycle end when your speed is falling, then close your induction motor switch again. I am assuming, of course, that your induction motors are of the squirrel cage type. These various points which I have mentioned do not make the parallel operation of the units any less satisfactory, but would merely cause a person to do a little thinking if he should attempt parallel operation without knowing the tricks of the trade, as it were. Before resuming my seat I would like to ask Mr. Burson a question in reference to induction motor frequency changing sets. As you all know, one of the big objections to large squirrel cage induction motors is their heavy starting currents. Now, as I explained a few moments ago, it is necessary in starting and paralleling one of these sets to throw the induction motor on and then take it off and then put it on the second time. What starting current will it take the second time the switch is closed?

Mr. Burson : It will take the current which it will have if it were operated running on the line, with a slip of 4%. It will not take the full load starting current.

Mr. Pratt : I would like to ask if there would be any difficulty in synchronizing two generators, one water wheel driven, and one steam driven, the steam generator being run at much higher speed than the water wheel driven unit.

The President : We have operated generators that are run from water power plants, in parallel with generators in other stations operated by steam, and experience no difficulty. We receive power from water power plants at Chambly, Lachine and also at Shawinigan, and also have auxiliary steam plants. We have connected those various stations, and we have no difficulty whatsoever in paralleling the steam plants with the water wheel plants.

Mr. Black : Mr. Pratt's problem is a little more difficult than appears on the surface. I think he refers particularly to 133 cycle generators.

Mr. Pratt : We expect to change to 60 cycle.

Mr. Black : Well, then, it largely depends on whether your machine is direct driven or belt driven, and it also depends on the nature of the governor of your engine. If it is a fast running machine, then there should not be any trouble at all, particularly if your water wheel capacity is large in comparison with the belted unit which is driven by the engine. In the case Mr. Thornton refers to, we found that by having the water wheel units on the line first, and putting everything in parallel with them, there was no difficulty at all. We could parallel engines that would not run in parallel by themselves, provided that they had the water wheel even angular velocity to steady them up. After you have started a number in parallel, then you could put almost anything in parallel with them.

Mr. Pratt : In this case the generator will be belt driven, and the engine will be high speed.

Mr. Black : How many cranks will you have ?

Mr. Pratt : One.

Mr. Black : I don't think you will have any difficulty.

Mr. Lambe : As a general rule, are not the difficulties of parallel operation rather exaggerated. I know a case where a couple of belt driven machines, high frequency, dissimilar make, are being operated on the same circuit in the same station, and are thrown in or out of parallel with the greatest ease. Then there is another point that also strikes me as being contrary to what would seem to be the general opinion, namely, the further apart you have your stations the easier it is to parallel them. The worst case is when your machines are side by side in the same building and direct connected to engines the velocity of which is not regular.

The President : I think what Mr. Lambe says is perfectly true—that there is a good deal of exaggeration, and if you ask a station operator, he would say there was no difficulty at all. Is there anybody else why has had experience with parallel operation ?

Mr. Macfarlane : I can only say that I have not had very much trouble in paralleling, and have come to the conclusion that practically any combination of engine and water wheel driven generators can be successfully run together, and have usually found this the most satisfactory way to operate even when the different units were some distance apart.

Mr. Fisk : In order to see that your synchronizing lamps are all right, it is a very simple thing to simply disconnect the terminals from one machine, and energize all the transformers from the other, and note if the synchronizing lamps show synchronism. If the lamps do not show synchronism, the connections should be so changed so that they will. If this rule is adhered to, it does not matter if the transformers are of different make, they are bound to come out alright I think this is a point which should be emphasized, as an inexperienced man may have a great deal of difficulty in trying to operate his machines in parallel because he has not got his phasing lamps properly connected.

Mr. Macfarlane : As to whether the machines are to be thrown together when the synchronizing lamps are dark or bright I think a very good way is to disconnect the leads close to the incoming generator and then close the switch of that generator the synchronizing lamps will thus either be bright or dark according to the way the transformers have been connected, and this is the condition the lamps should be in when the generators are thrown together.

The President : Well, gentlemen, if there is no further discussion I will proceed to the reading of the next paper. I will now ask Mr. A. J. Burson to present his paper on "Induction Motors." The paper appears elsewhere.

Mr. Burson : It is the aim of the above paper not to go fully into the theory of the polyphase induction motor, but to start a discussion. In my opinion more is to be gained from a live discussion than in any other way.

The President: Well, gentlemen, let us have the questions.

Prof. Herdt : Accurate testing of large induction motors is, as you know, difficult, besides requiring large amount of electrical power to carry out the test under full load. An accurate method for predetermining their performance without undergoing load test is evidently of great value. Having had occasion to test a number of induction motors, and also applying the circle diagram method, very satisfactory results were obtained and demonstrated the very close limits within which it works out. The circle diagram as shown to us by Mr. Burson is, however, of still more value for designing and allows the designer to work out clearly and with certainty a machine to give a desired performance. It is a pleasant duty for me to congratulate Mr. Burson on his able paper, for I have had the good fortune to have Mr. Burson as a colleague, he having left us only a few years ago. Since that time Mr. Burson has made a specialty of induction motor design, a subject of which he has by his paper to-day shown himself to be the master.

Mr. Black : I would like to ask Mr. Burson if this circle diagram can be applied to induction motors of the same type as made by the Stanley Compan, and whichy were exploited in Canada by the Royal Electric Company? They differ considerably from the motors now on the market.

Mr. Burson : The circle diagram can be applied to any induction motor, since it is theoretically correct. I might say that in our test room we make a complete test and circle diagram for each motor, and hence are able to determine accurately its performance, and where the design may be altered to advantage.

Mr. Black: How does the theoretical efficiency as taken from this diagram compare with that as given by the brake test ?

Mr. Burson: It compares very well. The only difference which may exist will be in the resistance losses in the stator and rotor. If both the circle diagram and brake test are carefully made, the variation should be negligible.

Mr. Black : In the squirrel cage type of motor the rotor resistance is very low, is it not ?

Mr. Burson : Yes, the resistance is low, but not so low necessarily as the resistance of a coil-wound rotor. As has been stated, the starting torque is proportional to the rotor resistance loss. In a squirrel cage motor, the rotor resistance is a fixed quantity, except for changes due to temperature, and if a large starting torque is required, the resistance of the rotor must be higher than if a small starting torque is required. In other words, an increase in resistance, within certain limits, results in an increase in starting torque. In the case of the coil-wound rotor, external resistance is introduced when starting and is cut out when the motor is up to speed.

Mr. Bucke : How do you measure the resistance of a squirrel cage rotor ?

Mr. Burson : The resistance of a squirrel cage rotor cannot be measured directly. The resistance loss, however, can be measured, and the effective resistance calculated. The resistance loss is determined by means of the static torque measurement, which is made as follows: In the stator circuit is an ammeter, voltmeter and wattmeter. On the rotor shaft is clamped a beam carrying a weight which is balanced against the electrical torque. This torque in foot pounds may be plotted against volts on the stator. More generally, however, the torque is expressed in synchronous kilowatts, that is, the output of the motor at synchronous speed for a certain torque value in foot pounds. It is equal to

$$\frac{W R \times 2 \Pi n \times = 746}{33{,}000}$$

WR = torque in foot pounds.

n = revolutions per minute.

From this value may be deduced the effective resistance.

Mr. Black: If the resistance of a coil wound rotor is very low, what means are taken to measure it ?

Mr. Burson : It may be measured by the ammeter-voltmeter method.

Mr. Lambe : How is the current in a squirrel cage rotor measured ?

Mr. Burson : The current in a squirrel cage rotor cannot be measured directly. If we neglect leakage, the number of ampere turns on the stator is equal to the number of ampere turns on the rotor. This value divided by the value of rotor bars gives the effective current per bar. Dividing the synchronous kilowatts by the square of the effective current gives the effective resistance. The current distribution may be worked out theoretically, but this is quite complicated.

Mr. Denis : You spoke of increasing the starting torque by increasing the rotor resistance. Do you get the same effect by introducing an auto-transformer in the primary ?

Mr. Burson : The effect is not the same. The auto-transformer is used to reduce the starting current by reducing the applied primary voltage. As has been shown, this results in a reduction, and not an increase in the starting torque.

Mr. Black : Could Mr. Burson give me this information about the induction motor ? Supposing that after it had been running a while, the bearings wear and the rotor gets off centre, what effect is that going to have on the operation of the motor?

Mr. Burson: It will have no noticeable effect until the bearings have worn to such an extent that the rotor rubs on the stator.

Mr. Lambe: When the rotor is off centre will not the magnetic field distribution be affected?

Mr. Burson: Yes, it will; but that will have no effect on the operation of the motor.

Mr. Black: Supposing a man buys a motor which he presumes is large enough to run his factory. He finds it will not start the load and is in a quandary to know what to do. I have known cases where the man in charge would saw the short circuiting rings between the rotor bars. I would like to ask if there is any better way of increasing the starting torque.

Mr. Burson: The only way to increase the starting torque of a squirrel cage motor is to increase the rotor resistance. This is done by decreasing the cross section of the short circuiting rings. Sometimes the starting torque of a motor—and hence its slip—will increase materially after the machine has been in operation for a time. This is due to the contact resistance between the rotor bars and short circuiting rings increasing.

Mr. Hilliard: How much can you increase the starting torque by increasing the rotor resistance?

Mr. Burson: The amount depends altogether upon the design of your machine.

Mr. Hilliard: Supposing you require a motor with high starting torque and low slip, would you recommend the use of a squirrel cage motor and a clutch?

Mr. Burson: That arrangement can be and is used with success. There are cases, however, in which it has not been entirely satisfactory on account of the character of the load. A motor with a coil wound rotor would give much better results. It would be more expensive, and take up a little more floor space, but the results would more than counterbalance these disadvantages. In purchasing a motor, it is best to explain to the company supplying it the exact conditions under which it is to operate, since their engineers are then able to decide upon the type best suited to the work.

Mr. Black: Mr. Burson speaks of the motor with a coil wound rotor being more expensive than a squirrel cage machine. On a 50 h.p. motor, what would this amount to?

Mr. Burson. I really could not say. The selling price is a question for the sales department.

The President: Too much starting current is a very objectionable feature. In the company which I am connected with, we insert a clause in our contracts stating that the motor will not introduce a disturbance on our circuits. In some instances we have had to insist on a consumer installing a clutch for starting purposes.

Mr. Black: Take the opposite condition, where the slip is too great, what method would you suggest of reducing it?

Mr. Burson: If the motor initially had too great a slip the only thing to do is to put in new short circuiting rings with less resistance.

Mr. Lambe: Is it necessary that an induction motor should have a very small air gap?

Mr. Burson: That altogether depends upon the guarantees which have to be met. As has been explained, other things being equal, a high power factor means a small air gap. The leakage factor varies, for small gaps, directly as the length of gap. The maximum power factor obtainable is equal to $\frac{1}{2\sigma + 1}$ where σ = leakage factor.

The President: As Mr. Wright suggested, we are here for information, and it seems to me we are getting quite a lot of it.

Mr. Black: I would like to ask Mr. Burson what he considers to be the highest voltage it is wise to use for induction motors, say a 50 h.p. motor.

Mr. Burson: It is not good practice to wind any induction motor for a higher voltage than 2500 volts. Of course, there are special cases in which as high a voltage as 66,000 may be used. For motors up to 75 h.p. 550 volts is about the best voltage to use, and above 75 h.p. 2200 volts is more desirable.

Mr. Black: Do you consider a 25 cycle motor better than the 60 cycle motor.

Mr. Burson: The 25 cycle motor is no better than the 60 cycle motor, except in cases where a very slow speed is necessary.

Prof. Herdt: In Germany, I think it is specified in all contracts that the motors shall have coil wound rotors. In fact I have seen very few squirrel cage motors over 15 or 20 h.p.

Mr. Burson: Labor is, of course, much cheaper in Europe than in this country. Also the coil wound rotor has reached a higher state of perfection there. Another reason for the use of this type of motor is that the European power company cannot and will not allow the heavy starting current necessary for a squirrel cage motor.

The President: I think some of us will have to put that restriction in our power contract.

Mr. Black: One great drawback to the induction motor is that when it is running light the power factor is very low. I would like to ask if there is any way of increasing the power factor at light loads.

Mr. Burson: The power factor may be increased by the use of capacity in the motor circuit. This however, is not altogether practicable.

Mr. Black: I take this opportunity to move a very hearty vote of thanks to Mr. Burson. I am sure we have derived a great deal of information from Mr. Burson's paper, and the thanks of the Association are due to him for the way in which he has answered the questions which have been put to him. Carried.

Professor Owens' paper came next on the programme, but owing to the unavoidable absence of the author, it was not presented. Prof. Herdt, however, kindly consented to explain certain curves and diagrams in connection with recent experiments as to the heating of enclosed conductors which had been made at McGill University, which was much appreciated and brought forth an interesting and instructive discussion.

The President: Is it the wish of the meeting that we now adjourn. It is now about half an hour before the cars will leave the Windsor. That will just give us time to walk up there, unless, of course, there are some questions that the members would like to bring up now, or any information that any member would like to have. As you have probably noticed, there has been a list placed at the Hotel for those who care to take the trip to Shawinigan Falls on Saturday. Of course, if a sufficient number do not signify their intention to go, it is impossible for us to ask for a special train, or to make any arrangements. This afternoon there are the visits to the sub-stations. We are leaving that rather open. One of the finest sub-stations in this city is in Maisonneuve, where the 50,000 volt current of the Shawinigan Power Company is brought into Montreal, and stepped down for local use. The Montreal Heat, Light & Power Company have a large sub-station adjoining the same, on the other side of the building. They have a very large synchronous motor, 5,000 K.W., a very large switchboard, etc., and altogether there is a lot of interesting data for men who are down here "looking for information," as Mr. Wright said. There is time this afternoon, after we get back, to go to some of the different sub-stations. I have just mentioned these as there are too many for the delegates to see in the short time that they are here. As there is nothing further, gentlemen, we will adjourn.

During the afternoon the members visited the stations of the Montreal Light, Heat and Power Company and the works of Allis-Chalmers-Bullock, Limited.

THIRD DAY.

The President : Following the plan of the programme, the first paper is that of Mr. Aitken on the "Economy of Isolated Plants." Unfortunately Mr. Aitken is unable to be present, so Mr. Campbell has kindly consented to read the paper for him.

Mr. Campbell then read the paper.

Mr. A. A. Wright : Well, gentlemen, I am sure we are very much indebted to Mr. Campbell for having read this paper for Mr. Aitken. It is certainly unfortunate that he is not here himself to answer any questions we might choose to ask, but under the circumstances we will have to do the best we can. I might say that I have no doubt myself that Mr. Campbell will be able to answer any questions on this point that you will ask from him. It is now before you for discussion, and I hope some of you will take advantage of it.

Mr. Campbell : I might say, Mr. Chairman, not being a central station man, I do not propose to discuss this paper in any way, but there are a number of station men and electrical engineers here, who no doubt have had experience in figuring out these problems the same as Mr. Aitken has done in his paper, and I would suggest that the central station men who have large plants under their control should get at this thing very vigorously, and fight it out to a finish.

Mr. Black : I think Mr. Aitken has given us a very valuable paper on a subject about which a great deal of misapprehension exists. The public have erroneously got the idea that all central station men are highway robbers and that they can do much better themselves by putting in isolated plants. Mr. Aitken has touched on the vital question of this problem, viz., the load factor. Most people do not understand why it is that central stations have to charge more for one class of service than another. A man has a general store or departmental store, and is selling one yard of cloth at the same price as a thousand, and he cannot get it through his head at all why it is that the central stations have to make a difference, due to the nature of the load which is going to be provided. Mr. Aitken's paper is of especial value, because it is based on actual experience, and actual experience is always ahead of theories, which sometimes do not come out just as they are expected to. Mr. Aitken is an engineer who has given a great deal of attention to this work, and he is capable of drawing very careful and accurate deductions from the data which he collects, and knowing him personally as I do, I know him to be very painstaking and careful in collecting data. If the owners of most isolated plants would take the trouble of putting on integrade watt meters and finding out actually what their consumption is, and divide that into the total operating cost and fixed charges, they would get a very much better idea of what their power was costing them per K. W. It is very common to make the assumption that if you have a 200 h.p. engine, you are getting 200 h. p., and you divide your total cost by 200 h.p., and you say it is costing say $25.00,or whatever it may be, per h.p. per year, for a 10-hour service.

Mr. J. J. Wright : Regardless of the load.

Mr. Black : Regardless of the load. That is where most people make mistakes. On the face of it, it seems funny that a central station which is operated by steam coal, can supply power two or three miles away cheaper than a man can make it himself. Any prospective power consumer who casually looks at it would say 'it is good common sense that I can make that power just as cheap as you can. You may get a little reduction in the price of coal, but you have got your line and all that to keep up, which is very expensive.' They do not realize the great difference there is in running a large plant, compared with a small one. There are some very valuable figures on this subject published in the Electrical News, November, 1903. This article, by Mr. Wm. O. Webster, gives the cost of operating various sizes of engines, and any person who is interested in this matter will get very valuable data from glancing at this table. Speaking from memory, I think this table shows that the cost of running a 2,000 h.p. engine, fully loaded, is in the neighborhood of $20.00 per h.p. per year on a ten hour basis, whereas running a 50 h.p. engine, it may be run up to $70.00 or even $100.00 per h.p. The mistake a great many people make is that they get hold of figures which have been given for large plants, and they assume that small plants can be run as economically. Another mistake which I think is commonly made in all isolated plants is that they make a test right at the start and assume that the plant remains in the same good condition as it was when installed by the manufacturer, whereas in two or three months after it has been in the hands of an ordinary man, who may or may not know very much about it, the cylinders and the valves may be entirely different. Except the engineer knows enough to put an indicator on his engines, say once a month, frequently the valves gets a little out of adjustment, and the coal consumption may be very different than when the plant was installed. The ordinary man who owns a plant has no check on it. He has to depend on the man in his employ, and not being a practical man, he is not capable of judging whether that man really knows his business or not. Another great drawback to these small plants is that the employer is entirely dependent upon the man operating his plant. He has one man, and he depends entirely on that man. Should this man fall sick, or go on strike, he is in trouble at once, and he has to pick up the first man that comes along, whereas by buying power from the central station, he has the full resources of the central men, who are composed of men ready and willing to give him satisfaction at once. Another thing—he has a big company that he can fall back on, and consequently get his power fixed at once.

Mr. Wickens : There is another factor to be taken into consideration. It is a considerable factor in keeping down the cost of the small isolated plant if it is properly installed. Of course, we have had a lot of very badly installed small isolated plants, and in that case there would be trouble, but there are some isolated plants that have been doing fairly well as far as cost is concerned. Where the whole matter is studied out, and the requirements followed, it should not be hard to repeat what the station man is doing for himself. I don't mean to say that we are going to be entirely as one on this question, because the central station men have 24 hours load, whereas the small plant have got to have a double staff, but do not have a good load for more than a few hours, and it becomes troublesome for a little isolated plant to run 24 hours every day. If you are only going to run ten or twelve hours a day, and utilize seven months in the year all your exhaust steam for a good purpose, and have your plant well arranged as to its capacity in proportion to its load, why you can reasonably hold your own against the ordinary central station people. If you go further, and run 24 hours a day, you have got to double up your help, and the cost finally gets so that you could get your power cheaper from the central station. Now, one of the points in connection with the isolated plants in these places is the fact that you have got very good control of the current while you need it, and there is always some place that can be turned off a little during the peak load, and a man, by manipulating it properly, should undoubtedly get a very fair result. However, I think there are places where the central station men have it all their own way, and I think there are places where the isolated plant man has it in his favor.

Mr. A. A. Wright : Now, gentlemen, we have heard from both sides. Is there anybody else who can give us any information—any practical points ? We have heard from the isolated plant man and from the central station man.

Mr. York : I am identified altogether with isolated plants, and I think we put in the first isolated plant in Montreal. I am glad to notice by the paper that there are some conditions in which isolated plants can be run to advantage. I think that it is proven that there are a great many of such cases, even more than what the lighting companies are willing to concede. I draw that conclusion from the great number of isolated plants that are being installed from year to year. All the owners of isolated plants are not making mistakes, surely. We must give these men credit for having some financial ability, if they have no electrical or other engineering knowledge. They look at it from the dollars and cents side of the question. They are not interested as to how much technical knowledge their engineer has, or where he comes from, but it is the amount of money that they have to pay out at the end of the year, expressed in dollars per ton of output of the works, or per yard of cloth, or per hundred pairs of shoes, as the case may be. A good many owners of factories do it that way. In one case that I have in mind just now, a company was advised that it would be a good thing to install a plant, and, so as to make sure that their advisor was advising them correctly, they adopted a method of this kind. They borrowed money from a certain fund they had for loan purposes and put in a plant costing about $6,000, and they also put in the necessary watt meters and so on. At the end of every month, they had the engineer render them an account for lighting, and then they paid the amount, that is, they paid into themselves the surplus or excess that it cost them to run the engineer's department, as compared with the corresponding month of the previous year. What was left over, they set aside to repay the money borrowed from this other fund, and by so doing, in something like two years and seven months, they repaid the entire cost of that installation, so that might be taken perhaps as a very favorable instance, and one where they left out the technical question as to how much it cost them per k.w. It was how much they would have to pay out this year and how much next year. I have another case in view here, in favor of an isolated plant in this city, where they installed a good many years ago what was then considered a modern plant, and some years later it was shut down, and they purchased their light from the lighting company. It remained closed down for, I think, six or seven years, and this year they have cancelled their lighting contracts and also scrapped the entire original plant, and installed a brand new one of equal capacity. Now, we must give these men credit for being able to figure out in dollars and cents what they are doing, so that on the whole I am sure the isolated plant has come to stay, and not in a few isolated cases, but in the great majority of cases, it will be found that the isolated plant will pay. Its particular advantage, of course, is in the use of exhaust steam in winter time. That is certainly a great advantage. As to the advantages mentioned by Mr. Black of having a very large corporation to fall back on, that, in my mind, is somewhat of a disadvantage, because if you have a small firm to go up against, and their is competition in the field, why you have a chance of dealing with them, but if it is a very great corporation, and they haven't any competition, then they simply talk nice to you, and that is all you get for it. (Laughter). Then, again, I can see why lighting companies, especially in this section of the country, are not very strongly opposed to isolated plants; it is because they have all the business they are able to handle at the present time, and at increased rates as well, so that, I think, would be sufficient reason why the companies here are not so antagonistic to the isolated plant as they otherwise might be if they were in competition for rates; so taking these things into consideration, I firmly believe that isolated plants will go on increasing and that there is even a still greater future for them.

Mr. Kelsch: I have listened to the remarks on this question of isolated plants. For a number of years I was connected with a large operating company who have made a special effort to remove all isolated plants in the city in which the company is operating. The company is now operating an isolated plant of 6000 k.w. capacity. This is a very large plant, nevertheless the firm receiving this power considers it cheaper to purchase it than own their own plant. While connected with that company, I had occasion to look into the cost of isolated plants, and there are a good many items that are never charged to the cost of operating isolated plants. In making up an estimate on one occasion, I found a large sum of money charged to legal and damage account. It amounted to over two thousand dollars and was a very large item on a small plant. It was in a D. C. plant where a man was accidentally killed and the two thousand dollars was charged to legal and damage account, instead of being charged to the cost of operating the plant. I did not expect to be here to-day to discuss this matter, but if I had thought of it, would have made a note of a large number of items that in ninety-nine cases out of a hundred, are not charged to the cost of operating isolated plants. I remember on one occasion, we went into a building to make up an estimate on the cost of operating an isolated plant, and on this occasion found that the plant occupied a space of 1500 square feet of very valuable floor space. The business of the firm was increasing and they were obliged to rent an adjoining building. In making up the cost of operating this isolated plant, we found that the additional building which the firm was obliged to rent was not charged to the cost of operating the steam plant, but charged to the regular rent account, while as a matter of fact, the space occupied by their isolated plant made it necessary to rent the adjoining building. During the holiday season, when many concerns are obliged to operate to their full capacity, and running overtime, the plant not being built for such a strain, is often overtaxed. There are many additional expenses at these times which we have found were not charged to the cost of operating the plant, such as extra meals for firemen and engineers, necessary to run overtime, etc. We have frequently found that where the regular force was incapacitated, the time of extra help was not charged to the cost of operating the plant. It is easy to find many other items never included by the owner of an isolated plant. Depreciation and repairs are seldom charged against the cost of producing light and power. On some occasions, we find that depreciation was allowed at the low rate of one and two per cent., whereas depreciation due to antiquasion, as well as the plant being outgrown, by the increase in business, very often makes the depreciation nearer twenty per cent. than two per cent. The average isolated plant, say, for example, has a 150 horse power engine, and it will be found that such plants have a load factor ranging all the way from ten to twenty-five per cent., which means poor economy. It has been remarked that an isolated plant has the advantage of the owner having control of the plant all the time. I think power from the central station is far better in this respect, for as a general rule it will be found that the owner of an isolated plant cannot use it outside of regular hours without preparing for such use during the day and at considerable extra cost, such as overtime for the employees, etc. My office here in Montreal is in a building having an isolated plant. If I arrive at my office half an hour early in the morning, I am obliged to ride up in an elevator that is dark almost to the danger point, due to the fact that the isolated plant which is supposed to be under the control of the owner is not ready to run. If I have occasion to be in my office in the evening, I have to burn a candle. I do not mean to say that there never was an isolated plant that did not pay. There are under certain conditions where a large amount of steam or heat is required, isolated plants that pay fairly well, and I think Mr. York, who has just described the method of his company in deciding on an isolated plant, has a successful isolated plant, due no doubt to the fact that they employ practically no more help to operate the same, outside of possibly an engineer, as they are large users of steam and heat.

The President: Now, is there any one else? Mr. Wright, you ought to be able to give some information.

Mr. J. J. Wright: Well, Mr. President, I can only speak from a slight experience. During the past year or two the isolated plant craze struck Toronto, and quite a few isolated plants were put in. I can only say that they are coming back one by one. I think that about ninety-nine are safely in the fold, and there is only one on the "hills far away." The last one to come back to us is an isolated plant that was put in on certain representations of the wonders it was going to perform, and it is a first class plant in every respect, thoroughly up-to-date, and in a first class location for manufacturing purposes, but the latest information I have is that our company has closed a contract to supply that company with power for five years. (Applause).

Mr. Higman: This paper does not deal specifically with electric lighting, but comes sufficiently near the subject to admit of the presentation of a few statistics on the condition of electric lighting in the State of Massachusetts. I had the opportunity a short time ago of reading the report of the Board of Light Commissioners for that State and gleaned from it the following facts. Of the total number of plants considered 21 are under municipal control and 82 under private enterprise. In 1904 the total income of the 103 systems was $7,663,961, and after deducting all expenses including interest and depreciation there was a deficit of $465,422. One of the private companies did not earn sufficient to pay working expenses; some companies were unable to pay any dividends, while others paid dividends varying from 2 to 10 per cent. The total capital invested in municipal plants is about $3,000,000 and the total assets of the private companies amounts to about $30,000,000. There was a direct loss of $85,055 on the municipal plants during the year, but to this must be added $61,725 for interest and $85,841 for depreciation, making a total loss on the year's operations for the municipal plants of $232,631. I am speaking from memory, but I think the figures given will be found to be substantially correct. As tax-payers it is well that we should consider, very seriously, what the prospects are of earning dividends or even meeting working expenses on investments of this nature.

The President: I do not wish it to be understood, nor would I like anyone to understand, that I make the assertion that the isolated plant under no circumstances will pay, as there are exceptional cases, of course, as we all know, where an isolated plant is all right, but taking the large proportion of them, I think it will be found that energy from the central station can compete with them quite easily.

Mr. Black: Mr. York, in his remarks, says that while the business men may not be engineers of ability, they are masters of finance. I have in mind a bank building where they have installed a large isolated plant. The bank has a general manager who is drawing a salary of probably $25,000 a year, and a local manager who is drawing a salary of say $10,000 a year, and several other highly paid men. These men might be called captains of finance. At the same time they have installed an isolated plant which should never have gone into the building. As far as I can find out, the only data that they have got on this matter was to ask the architects whether they were to put in a plant or not. They put in an isolated plant to run an elevator which probably does not run more than once or twice an hour, and also do a little lighting. We all know the banking men do not stay at their offices as late as we electrical men do, so they do not use very much artificial light, and the plant has to run all day just to run an elevator. I am quite sure that the local supply company could supply current to be used in a legitimate way for less than half the cost, not to speak of the amount of capital invested which should be charged against that plant for floor space, smoke stack, and so forth. Mr. York also referred to the fact that central station men were not very much opposed to isolated plants; in a great many cases they are not; the isolated plants are really a help to the supply companies. The business is growing in a great many cities so much that it is hard for the companies to keep up with the business. Another point—the isolated plant is a splendid advertiser for the other companies. The people who own the plant use light recklessly, as they think it does not cost them anything, which is a splendid advertisement for the supply people. For instance, take a departmental store on the main street which I have in mind at present. This store and the adjacent stores are a regular blaze of light, simply because the plant in their basement "does not cost them anything." The neighboring stores get their lights from the supply companies, and consequently have to burn more to keep up with their ill-advised neighbors. In that way the isolated plant is a great help to the supply company. I know of an isolated plant in a departmental store where they do this. The departmental store is six or eight stories high, the front being almost all glass, and they own several of the adjacent stores, which they rent. With the rent they give the electric light free, simply because "it does not cost them anything." In one case they objected to one of their tenants burning 16 c.p. lamps, and they made him put in 32 c.p., simply because it gave a better appearance to the place, and "they had to run their plant anyway," so that in a great many cases isolated plants are a good help to the supply company.

Mr. Burran: Mr. York mentioned that in a place where they have to have an engine and boilers for their purposes, that an isolated plant would pay in almost every case, I think he said, if not in every case. I have in mind a hotel that a year or so ago was in a similar position—they had to have an engineer and fireman, and boilers, and that sort of thing. They had been running from a central station for a few years, and consequently knew very well what the cost was. They had an elevator that had to run all day, and they also had something like seven or eight hundred lamps, so it was not a very small thing. They were persuaded to put in an engine and generator, and were told they would save a large amount of money, because they could utilize the exhaust steam not only in winter time for heating, but in summer time for cooking, and further other purposes, so they got their plant, and in about four months they spent for coal and a few things of that kind all that they had paid the previous year for their lighting and elevator service. It was only about a month after that when their dynamo was on the market, and the plant sold.

Mr. Campbell: I am pleased at having had the opportunity of reading a paper which has brought out so much discussion this morning. It seems to me that this discussion has been wanting in the past few days. But this is a subject that seems to have struck them in the proper mood, and it certainly is a very interesting discussion. I am sure if Mr. Aitken, the author of the paper, were here, that he would have been delighted to have heard the discussion that has taken place over it this morning.

Mr. A. A. Wright: I would like to move that the thanks of the convention be forwarded to Mr. Aitken for his paper, and I am very happy to be able to endorse, so far as my experience has gone, everything that he has said in the paper.

Mr. York: I take great pleasure in seconding this motion. Carried unanimously.

The President: We have another paper this morning written by Mr. McKay on "Steam Engines and Boilers." I understand that as Mr. McKay is unable to be present, one of the gentlemen will kindly consent to read the paper.

Mr. Wickens read Mr. McKay's paper.

The President: We are very much indebted to Mr. Wickens for reading Mr. McKay's paper. I hope there will be some discussion on this subject. Before going on with the discussion, I might say that I hope that the members of the Executive who are present will wait for a few minutes after this meeting. This afternoon there will be the matter of the election of officers to take up, and also a few of the questions in the Question Box.

Mr. York: I do not think there is very much to say in regard to this paper. It is certainly very instructive, and should be kept on file. There are some very good points contained in it, although there are one or two little points that the writer evidently overlooked, that is, in reference to the careful firing part of it. My experience has been that if you want to get the best economy from coal, you must leave the fireman out of the question. If you are going to depend on the fireman, you are not going to get what you are looking for, that is, in the majority of cases. If your furnace is so wide that he can keep up steam with holes in the fire, that is the way he is going to do it. It will be easier for him. If the steam does not come down, he will not worry about what is going on in the furnace. If you have a variable load at different times, it would pay in a great many cases to have two boilers. The average fireman will not try to save the coal—you can get some few who will, and in large establishments especially I think the better way is to leave any economy, as far as the fireman is concerned, out of the question. That has been my experience.

Mr. Wickens: Mr. McKay starts out in a very good way, because the first statement that he makes is that we have got to look to the boiler, and it is no use splitting hairs about the engine—that our boilers are perhaps the wasteful source in so far as the use of steam is concerned. Of course, there is another point in connection with steam plants. They do not take care of their boilers. The difference between a dirty and a clean boiler is very marked. Then, as far as cleanliness is concerned, there is nothing so bad for a boiler as an accumulation of oil inside of a boiler shell. By experiments that have been conducted along that line by some very eminent engineers like C. Y. Williams, D. K. Clark, and some of those gentlemen, they proved conclusively that oil is perhaps the worst conductor we have. The difference between the heat of the sheet on the fire side, and upon the water side, if the boiler were perfectly clean, was about 79 degrees. When they put the very finest film of oil on the water side of the sheet and then fired it up, the difference between the heat of the sheet on the two sides was 190 degrees. As they thickened the oil slightly, it went up to nearly 300 degrees and finally it got into such a heat that the sheet was beginning to show signs of being burnt; in that case it would not be long before the bottom was burned out of the boiler. This was in an experimental boiler, and it only goes to show that there is a very large amount of waste by not having the boilers clean.

Mr. A. A. Wright: I would like to ask Mr. Wickens how the oil gets into a boiler under ordinary circumstances.

Mr. Wickens: In the first place, if you are using your water from a condenser, your exhaust steam carries the cylinder oil with it, and it gets into the hot well through the air pump. Of course, you may say we will make a well four or five feet deep, and we will run our pipe away down, and we will not get any oil in that way, but the water would be perhaps 150 degrees hot, this much cooler than the steam. Steam just carries the oil into that water in the form of spray, which strikes the cooler water, this collects the oil again, and the feed water pipe is sure to take oil and water alike and deliver all to the boiler.

Mr. H. W. Weller: I, unfortunately, have just arrived, and did not hear Mr. McKay's paper read, but I had a copy of it, and I looked it over, and I find one or two little things that we should certainly take exception to. Of course, it seems hardly courteous to criticize the paper when a man has taken a great deal of trouble and pains and care in writing it for the benefit of the Association, but as I think you are all in search of information, you do not wish to be misled unless you are misled with your eyes open, and that must be my apology for making a few remarks. First of all I notice that Mr. McKay takes the stand that no boiler should have more than 35 square feet of grate surface. Well, of course that is all right, provided the manufacturer of the boiler is limited by his special features of design to that grate surface, and possibly that may have a little to do with Mr. McKay's remarks; but I would make this statement, that in all plants, or in 75% of plants of say 500 h.p. and upwards that are to-day operating, a great many installed by engineers of very high repute, you will find that the average grate surface is from 60 to 80 square feet, using the larger boiler units, and I think that this latter is nearer the correct size when you get into larger plants of two thousand horse power and upwards. For instance, you take a plant of two 250-h. p. boilers, they each have between fifty and sixty square feet of grate surface. I do not think that there is any difficulty, even with the ordinary class of fireman, in covering a grate of even eighty square feet if necessary, and cover it evenly, so that you will not be troubled with cold air getting through. Of course, with regard to the question of internal fired boilers, this is rather a tender subject to touch upon, especially standing, as I do, as the representative of Babcock & Wilcox, Limited, probably the largest boilers manufacturers in the world. We claim, of course, that a brick set boiler is the thing, and of course we have reasons for thinking so, outside of the fact that we are exploiting that particular boiler. We think that in the internally fired boiler there are several serious objections, especially for electric plants. In electric plants, where the fluctuation of load is quite considerable, it is necessary to have what we call a quick steaming boiler, a boiler which you can force readily from half load to full load, or even 50% over load, with the least possible delay. Now, I know that you cannot do this with an internally fired boiler, and I consider that it is very dangerous, even if you could do so, on account of the expansion and contraction not being properly provided for. That is a fact that I think is known to most engineers. As regards the economy between an internally fired boiler and a brick set boiler, that is, of course, a point on which a good many engineers, I presume, differ. If you are going to run a plant for five or six hours, and then shut it down, and let it cool off altogether, there is a certain amount of objection to a brick set boiler, but that is not the condition that we meet with in everyday practice. Brick setting, of course, will absorb some of the heat at first, but after you have got it heated up, you get far better combustion, and consequently better economy. I might mention that quite recently there has been a very careful series of tests made by authorities which I think no one will question, and that is the British Admiralty. They have made a series of tests quite recently on four battleships, all identically similar except in the boiler equipment. There has always been a feeling amongst some of the older engineers in the navy that for certain conditions the internally fired or Scotch marine type is preferable, especially, as they claimed, for steaming at ordinary cruising speeds; consequently in the last four battleships, they installed, in the first one (I think it is the King Edward VII), two-fifths of cylindrical boilers and three-fifths of Babcock boilers which are essentially brick set as regards the furnace, even in the marine type. In the second ship (I think The Dominion), they installed one-fifth of cylindrical boilers and four-fifths of Babcocks with the brick set furnace. In the other two that were last completed they are all Babcock boilers. They have made a very careful series of tests, extending over many weeks, taking the actual amount of fuel per indicated horse power on the engines, operating at different speeds, at one-half, three-quarter and full speed, and in every case it showed that the fewer of the internally fired boilers that they had on the ship, and the more brick set furnace Babcock boilers they had, the higher the economy they obtained. These figures are on record, and can be seen by any of the members who wish to do so. I do not know that there is anything further that I can say, and I hope you will pardon me for having taken up your time in making this statement, and I am sure that you will do so on account of the fact that we are all here in search of information.

Mr. Farmer: Mr. Chairman, I should like to endorse to some extent the remarks made by Mr. York in regard to the fireman, and his bearing on the economy of firing a boiler, and the particular remark which struck me was this—that it is not always fair to charge to the fireman the falling off in efficiency which occurs when making a test on a boiler. I think that it often happens that the fireman is unable to get the economy out of a boiler that he would if the conditions were better planned for him, and of course the condition which can be pre-arranged and very greatly bears on the efficiency on a boiler, is the amount of grate surface provided, and this is a difficult subject to approach on account of the difficulty of obtaining exact information on the subject. Of course, there are two errors that can be made, one by giving too little grate surface, usually in making the grate too narrow, when you have to put on too large a force of draft in order to get the necessary rate of combustion, at a higher rate of combustion per square foot. The difficulty in maintaining the high pressure is that it dislodges the coal, and the fire from that cause burns unevenly. On the other hand, if you have too great grate surface, it is difficult to keep the draft down to a sufficiently low point. The coal burns away too rapidly. The pressure of the amount of steam generated is temporarily above the normal, and the fire has to be allowed to burn down to a certain point or else you would be making more steam than is required. Again, loss in firing is due to heating more air than is actually required for combustion. There are lots of tables illustrating this point, and it is very striking when a comparatively small increase in the amount of air used in combustion occurs, what a large amount of heat is wasted from that cause. Now, it may be interesting to give some concrete figures on this point. I have had the opportunity of making a considerable number of tests on boilers in various parts of the country in the last few years and the results of course are very variable, and make it very difficult to get down to any final conclusion, but I should like to mention one test particularly, made at the Manhattan Elevated Railway plant at 74th street, New York. That plant is equipped with Babcock & Wilcox boilers, of I think 525 h. p. each, and they are so arranged that the coal has to be burned on the grates at the rate of approximately 20 pounds per square foot of grate surface. I mention this Manhattan Elevated test for the reason that that was the lowest amount of air that I found, with one exception, in a plant working under the ordinary commercial conditions. The amount of air taken was a little under 20 pounds of air for a pound of coal. There has to be a certain amount for dilution over the twelve pounds theoretically necessary, but you will find that the amount in an average plant varies anywhere from 24 up to 40 or even 50 pounds, so in that way 20 pounds of air may be taken as a very good working condition. The coal used on that occasion was a semi-bituminous, procured from Pennsylvania. On the whole, my opinion would be, and I think it would be endorsed by most practical boiler men, that it is well if anything to err on the side of giving too much rather than too little grate surface. It is easier to maintain economical results when you have a little excess surface to go upon, rather than when you have a limited surface.

Mr. Wickens: I think Mr. McKay refers to the amount of grate surface for a 100 h.p. boiler, which means 35 square feet for 100 h.p.

Mr. Weller: That is entirely too much—35 square feet is too much for a 100 h.p. boiler.

Mr. Wickens: I have in many different cases seen boilers with eighty and ninety square feet of grate surface on them.

Mr. J. J. Wright: Perhaps there is a little misapprehension in this matter. I think that Mr. McKay referred to single fire door, and 35 square feet of grate surface, five feet wide and seven feet long, as he states it, as the limit of reasonable firing.

Mr. Weller: I think what made Mr. McKay give that figure five feet wide, is that the five foot wide furnace is the largest they can put in their boilers, if I am not mistaken. Of course, it is really a question of doors as regards the width. Now, I will agree with Mr. McKay as regards the length, as seven feet is about the limit that a man can cover properly from the front without using automatic stokers, but as regards the width it is simply a question of fire doors. On the wide boilers we make, our practice is to sometimes put four fire doors, usually a fire door for about every three or four feet of width in the furnace.

Mr. Black: In the absence of Mr. McKay, I think that as Chairman of the Paper Committee, I can throw some light on this point. The Executive have been criticized in the past for getting papers that were too difficult for the average central station man, and the Executive instructed the Paper Committee to try and get papers which would interest the small central station man, and this paper which Mr. McKay wrote for us was written from notes which I supplied him, and in these notes I asked Mr. McKay to give information on boilers and engines which would help them to install a small plant. I made a note about installing a plant of 100, 200 and 300 h.p. and asked him if he would put in one, two or three boilers and whether they would be return tubular or water tube type, and also asked him to discuss in the paper how this would affect the first cost and operating cost, and I think possibly that is what Mr. McKay has referred to, and that I limited him more or less to small plants.

Mr. Wickens: I move that a vote of thanks be tendered to Mr. McKay for his paper.

Mr. Reesor: I have much pleasure in seconding that motion. (Carried unanimously).

Mr. Reesor gave notice that he would move at the next session of the Association to amend the constitution, by admitting to membership all those engaged in the electrical business. This was seconded by Mr. J. J. Wright.

Upon motion of Mr. Black, resolutions were unanimously adopted tendering the thanks of the Association to the following:

To Mr. H. D. Bayne and members of the Local Committee, for the very complete arrangements made for the comfort and pleasure of the members while in attendance at the Convention.

To the Secretary of the Canadian Society of Civil Engineers for their kindness in placing at the disposal of the Association their well appointed quarters in which to hold the business sessions of the Convention.

To the Allis-Chalmers-Bullock Company for kind hospitalities extended to the members while in attendance at the Convention.

To the Montreal Light, Heat & Power Company for courtesies extended to the members while in attendance at the Convention.

To the Montreal Street Railway Company for kind courtesy in giving free transportation to members over their lines during the Convention, and for the conveniently arranged books of tickets prepared for the use of members.

To the authors of papers for the able and instructive papers prepared and presented at the Convention.

To the Secretary of the Engineer's Club for courtesies extended to the members while in attendance at the Convention.

To Mr. A. A. Dion for the valuable work which he performed during the last two years as editor of the Question Box.

The Convention then adjourned until the afternoon.

FRIDAY AFTERNOON SESSION.

The President: Before we proceed to the election of office bearers, I think we should first have some expressions of opinion, and eventually a vote, on the place of next meeting. I do not know if there is any particular way in which we should take that discussion up, but it is one of the things that we have to decide upon this afternoon, and as I understand we have one or two invitations, I would ask the Secretary to read these, and then I would like to hear from the members as to what place they personally consider the most suitable for the next meeting, and then we can vote on the matter.

The Secretary thereupon read a telegram from the President and Secretary of the Halifax Board of Trade, inviting the Association to hold their next annual convention in that city, and also a letter from Mr. G. A. Powell, of Winnipeg, stating that the matter of holding the convention in the West had been considered to some extent, but that nothing definite had been arrived at.

The President : I might mention, before going on with the business before us, that the Forest Wireless Telegraph Company extend an invitation to any of the members who can visit their offices in the Coristine Building. This invitation is extended by Mr. Hughes, their electrical engineer. Is there any suggestion now from any of the members as to the location for next meeting. I have heard several expressions of opinion of suitable places from Halifax to Vancouver.

Mr. Williams: I would suggest Niagara Falls as being a very suitable place for next year's meeting, on account of the immense electrical developments that will be finished by that time. I am sure it will draw a large number of members.

Mr. A. A. Wright : Mr. Chairman, is there anyone present from Halifax who could give us any reliable information about that city. It is certainly very desirable that we should in the very near future go to Halifax, and in the not very far distant future go to Winnipeg. Just now it is the dog that wags the tail, but it will not be many years when it will be the tail that is wagging the dog. I would like to ask if there are any electrical plants in that city, and if there are any in Newfoundland, and how much it would cost to go from here (we would have to have a Pullman car, I suppose), and how long it would take. It is very desirable to go to Halifax—there is no doubt about that. If we can do any missionary work by going east, I would like to go. Still, I would not like to jeopardize the working of the Association.

The President : Mr. Starr, of Halifax, might be able to give us some information.

Mr. Starr : Mr. President, I regret that there are no station men from Halifax present at the meeting, or, in fact, from the Maritime Provinces, and that in itself, I think, would be a very good reason why the Association should go to Halifax. At the last Convention in Hamilton, there was one station man from the district east of Quebec. At the previous Convention in Toronto, there was only one. One advantage for the Convention to meet in Halifax would be that it would bring in without doubt a number of members, and in after years these members would attend the Conventions held in this part of the country. In reply to Mr. Wright's enquiry as to the plants in the Maritime Provinces, I might say that in addition to a number of others, there are large plants in Halifax and St. John, and, as you are probably aware, there is a very large plant at Sydney—that of the Dominion Iron and Steel Company—one of the largest in the Province, and I think I am safe in saying one of the largest of the kind in the Dominion. That could be reached from Halifax as a side trip, and, of course, at the same time you would have a glance at Cape Breton and the coal district. As to the cost, I think that would be very much less than going to Winnipeg. The Intercolonial Railway would give return fare on certificates for one fare. The single fare from Halifax to Montreal is $16.50, exclusive of Pullman. The Pullman fare is $4.00 from Halifax to Montreal. I think it would be a very good move on the part of the Association to go to Halifax, and while I am not asking to have any particular date set for the meeting, if it could be arranged to have the meeting in September, the Dominion Exhibition will be held in Halifax next year and it might be well to hold the Convention at the same time. Of course, I do not know whether that meets with approval, but I certainly think it would be a very good idea, and would tend to increase the membership of the Association, and in after years the members would come up here, whereas at the present time they have no representation at all. As far as the social end of the affair is concerned, I can assure the members they would be well taken care of.

The President : My own personal opinion is that the majority of central station men hate to be away in September. They are beginning to get ready for their fall load in September, and generally speaking you have a great rush to get through with your preparations to take care of your fall load. I do not know if that is the experience elsewhere. It is usually my own experience. Many of us consider that the most suitable time is like the present, in June, when you are not worried about taking care of fall loads.

Mr. Pilcher : I fully endorse what Mr. Starr has said in reference to Halifax, and it has also occurred to me that at Conventions of this kind, while it is true we all like to visit the large installations that have been put in from time to time, I believe if you go to Halifax you will get down to business, and there will be a little more business done at the meetings by leaving these side trips out. I am sure, if we have one meeting in the Maritime Provinces, we will get at least 25 members the first year. It is out of the question to go to Sydney, because it will take another 12 hours. I was rather amazed when Mr. Wright spoke—I hope the members will excuse me for rubbing it in—but there is a gentleman representing a section of the Dominion, and he does not know anything about the Maritime Provinces. That is why I say come down and see it.

Mr. Higman : The Civil Engineers went down to the Maritime Provinces and other points, and they found it the most enjoyable trip of their whole experience. They were fortunate enough, however, to secure free transportation.

Mr. Pilcher : Really, I believe the Intercolonial Railway Company are so anxious to have people go down there that we would get very liberal discounts from them. I simply give it as my own experience, and I feel quite sure that if the Association approached the Intercolonial Railway, they would be very kind to us indeed.

The Secretary : It might be interesting if Mr. Pilcher or Mr. Starr would give us some idea of the probable local attendance at such a convention. Of course, we might naturally expect that the attendance from the west would be much smaller at a meeting in Halifax than it would be in Montreal or Ottawa, or the West, and it would be interesting to know how many would be likely to attend from the Maritime Provinces.

Mr. Pilcher : Judging from my own personal experience of the people down there, and the interest taken in electrical matters, I think that we would get at least twenty-five station representatives. I do not know whether that is right or not. Mr. Starr and Mr. Rough know the people even better than I do, but I think I am quite safe in saying twenty-five.

The President : Are there any other expressions of opinion. Will anybody make a definite motion?

Mr. Bucke : I think it would be rather interesting to find out from those here at the present time how many would go down to the Maritime Provinces in case the next Convention was held there. Twenty-five is a small number for a convention, and I do not think anything like that number would go down. I would be very much in favor of Mr. Williams' suggestion to go to Niagara Falls. They have got three big power companies there, and two of them at least will be operating next year, and probably three. They are putting up a new hotel at the present time, and there will be splendid accommodation. Some of the members have suggested that we hold a meeting of the Association in transit. We could charter a boat and have a meeting on the boat. You can do anything you like from Niagara Falls—you can go over to Toronto or Buffalo, and there are all kinds of things to do from that point. I think Mr. Williams' suggestion is the better one.

Mr. A. A. Wright: Well, now, Mr. Chairman, is it necessary that this thing should be decided to-day? How would it do (if we put it off for another day), for your humble servant to interview the Minister of Railways, and see what he will do for us. Being one of his good supporters, I might have perhaps a little more power than some others, and we could find out definitely what he can do for us, and see if it would not be possible for us to go down. I would be willing, as Artimus Ward says, "to exert my ability in that direction."

The President: I believe by Article XIV of the constitution, the next place of meeting is selected at the annual meeting.

Mr. A. A. Wright: That lets me out.

Mr. Williams: I move that the next meeting be held at Niagara. I know if you go down to Halifax, I for one could not spare the time to go.

Mr. Purcell: I would like to second that motion. I think that the trend of traffic is towards the west, and with another meeting in Ontario, it might be advisable for us to meet in Winnipeg the next year.

Mr. Hamilton: It seems to me that the Association can hardly afford to take a selfish view point in considering this matter. The Association is broad in its intentions and scope, and should take in all the station men in Canada. Those on the Pacific Coast are pretty much out of reach, but certainly the Maritime Province men are not, and they should be given a chance to get some of the benefits of membership. Now, the National Electric Light Association has its meetings all over the United States, and those who cannot go one year are able to go the next, and in that way they all get some benefit, but as it is here, it would appear to be the object of some to keep it in the western part of Quebec, or in Ontario. It seems to me that the matter should be looked at in a broad way, and if possible things should be so planned that a little wider scope can be given, and membership can be secured from a wider territory. (Hear, hear).

Mr. Purcel: How many members, I might ask, are there in the maritime Provinces, and in the western provinces, not including Ontario?

The Secretary: If you mean east of Montreal, and west of the Soo, I could not say, but they would be very, very few; perhaps twenty would cover it.

Mr. Hamilton: Why should there be many? They have never had any inducement.

Mr. Pilcher: The discussion seems to be on the principle that Nova Scotia only wants a convention once in fifteen years. That is about all.

Mr. Macfarlane: I move that the Association meet in Halifax next year.

Mr. A. A. Wright: I second that motion, because I do not think we will go there. I am bound to be on the winning side any way, but really I think that if we do not go there this next year we might next. I am very glad it has been brought to the notice of the meeting, because I think we ought to try and go there at least the year after, and I think in the meantime we should get all the information we can, and see what we can do by going there. We must not be too selfish in this work. There are many respectable people living down in the Maritime Provinces, and we might like to go and see them. I would like to say another thing, and that is that we invariably pick out the big hotels for all the station men to go to—at least we all go there. Now, we are not all millionaires in this world, and if we continue in the electrical business I don't think we shall ever be, so I think we should pick out accommodation at some moderate price respectable hotel, where any man can go, and have our meetings in the very best place we can. It is not necessary for us to put on airs.

Mr. Williams: I do not think that the Association selected any particular hotel in Montreal.

The President: As far as the arrangements in Montreal were concerned, I practically made them myself, and I purposely left the hotels out, as I felt that some of the members might want to please themselves in this respect. I went to the Windsor Hotel and tried to arrange special rates, but they were not too anxious to receive us, and rather than make any distinction, I thought it would be best to make headquarters at the Canadian Society of Civil Engineers' rooms.

Mr. A. A. Wright: I might say, Mr. Chairman, that I did notice that, and I was very glad to see that you did so. Still, notwithstanding that, we must understand that our Secretary was there, and the room was there where we got our vouchers, and although it was not said so in so many words, yet we could read it between the lines.

Mr. Black: It seems to me that the Convention has been a great success (hear, hear), simply because we have come to a place which is more or less central. If we hold our meetings at places where we will get a large local following, it keeps the prestige of the association up, and that we cannot afford to lose. At the next Convention, instead of having 320, as at this convention, I think we should have at least 400. Now, from an economical point of view, it seems to me that it would be better for the Association to keep the convention in a central place, where the majority of the member could be present. I sympathize with the members, and those who are interested in the electrical business, who live outside of the central portion. It is certainly a drawback to them not having a convention that they can easily reach, but if we can do somebhing so as to defray their expenses, that should overcome the difficulty.

Mr. Starr: I would like to correct an impression made by the last speaker, Mr. Black, in suggesting that the Association might defray the expenses of those too far away from the place where the convention is to be held. It is more owing to the fact that the benefits of the Association are not known to the central station men down there, and that is one reason, if the convention went down there, and induced these men to join, they wonld be glad to come up here in future.

The President: I will have to bring the matter to a head now, so if anybody has anything to say in the matter, I wish they would say so. We will have to put the question box before the meeting after.

Mr. Black: Is everybody entitled to vote on this?

The President: According to the constitution the only people that are supposed to vote are the active members, but still that does not prevent the associate members from giving a general expression of opinion, which I am sure would influence the active members.

The matter was then put to a vote, the method adopted being by a show of hands. Five voted in favor of holding the next convention at Halifax, and the remainder in favor of Niagara Falls.

The President: I think we will now proceed with the election of office bearers, and it is necessary to appoint two scrutineers. I appoint Mr. Purcell one, and Mr. Fisk the other.

The President then read Article XVII of the constitution.

It was proposed by Mr. Higman, and seconded by Mr. Black, that Mr. A. A. Wright be elected president for the ensuing year. Carried unanimously.

Mr. A. A. Wright: I must say that I certainly thank you most heartily for the gift you have conferred upon me—the highest gift in the hands of the Association. I do not know whether I shall be able to fill the office or not, but if I am to occupy it for the ensuing year, I shall endeavor to fill it to the best of my ability, and I hope that at the next meeting we will have just as good a meeting as we have had this year, and perhaps a little better.

Mr. J. J. Wright: Mr. President, I have great pleasure in nominating Mr. R. G. Black for the office of first vice-president.

Mr. Macfarlane: I have great pleasure in seconding Mr. Wright's motion. (Carried unanimously.)

The President: Now, gentlemen, the second vice-president.

Mr. J. J. Wright : I suppose it is in order for one member to nominate two members. I nominate Mr. John Murphy as second vice-president.

Mr. Higman : It affords me great pleasure to second that motion.

Mr. Black : I have very much pleasure in nominating Mr. C. H. Mortimer for the position of Secretary-Treasurer. Mr. Mortimer is centrally located, and as the convention is to be held next year at Niagara Falls, I think Mr. Mortimer can fill that post better than any one else.

This motion was seconded by Mr. Burran and carried.

Mr. Thornton : Mr. Wright, as you are now President of the Association, you might come up and take the chair.

Mr. A. A. Wright : I have got to go in a few minutes.

Mr. Wright thereupon took the chair, and said: I thank you, gentlemen, for this warm reception.

Mr. Murphy : I would like to take advantage of the temporary absence of our President from the chair, to move a very hearty vote of thanks to him (Mr. Thornton) for the admirable manner in which the arrangements for the convention have been carried out.

This motion was greeted with prolonged applause.

Mr. A. A. Wright (President) : I have much pleasure in conveying the hearty clappings of this meeting to yourself, and also to inform you that all these clappings were for you.

Mr. Thornton : I can assure you, gentlemen, that I thank you very heartily for your appreciation of any little work that I may have done. Personally, I may say that it has not been very hard work, because I have been really interested in the work. I have always been interested in the Electrical Association, and have always believed that it is in the interest of the central station men generally to belong to such an association. I have felt for a long time that we ought to get down to serious work, if we want to have the work of the Association kept up to standard. I think that a convention should be a case of hard work for the delegates. I have no doubt that some of the members have found it hard work, but I do not know whether it was altogether from attending the meetings. I thank you very heartily, gentlemen, for the expressions of your good will.

A ballot was then taken for the members of the Executive Committee.

Mr. A. A. Wright (President) : I have much pleasure in declaring the following officials our Executive Committee for the ensuing year: Mr. A. A. Dion, Mr. B. F. Reesor, Mr. J. J. Wright, Mr. J. A. Kammerer, and Mr. C. B. Hunt. The next thing is the election of five more, as I understand it.

Mr. J. J. Wright : I would like to suggest that our Secretary send a courteous reply to the Halifax Board of Trade, setting forth the reason why the delegates could not decide in favor of Halifax, and so on, and that certain conditions make it necessary to hold our convention elsewhere.

Mr. A. A. Wright : That is a very good suggestion, Mr. Wright, and I have no doubt the Secretary will act accordingly. There is another matter that we should take into consideration, and that is the gratuitous labor that Mr. Dion has given us in preparing questions for the Question Box, and sending out lists. This is becoming more and more an important feature in our association. It is one of the most advantageous forces that we have, and I think it is one of the reasons why members are added to the institution. I think some one should say something on this point.

Mr. Thornton : I have very much pleasure in moving that a very special vote of thanks be granted to Mr. Dion, and that the Secretary be instructed to write to him accordingly. We have not had very much time to take up the Question Box as a part of the programme, but I do not think that we can infer from that that the Question Box has been in any way slighted. The discussion this year of all the papers has been very good indeed, very much better than a great many conventions that I have been at, and there are many questions that have come up in the discussion, dealing with matters contained in the Question Box, and many of the questions have been answered in this way. I consider it is a most important part of the Canadian Electrical Association, and it ought to be continued, and Mr. Dion deserves our sincere thanks.

Mr. A. A. Wright : I might suggest that we request Mr. Dion to take charge of the Question Box for another year.

Mr. Thornton : I am afraid he will not do that. He told me that he certainly would not. He has certainly made a success of it. If we can induce him to take it up and carry it on for another year, I think we ought to do so.

Mr. Burran : I have very great pleasure in seconding that. I think Mr. Dion has done a very valuable amount of work. The onus of the work has been on Mr. Dion, and I think he deserves the best thanks of the Association.

Mr. A. A. Wright (President) : Is it your wish that it should be carried? (Carried unanimously.)

Mr. A. A. Wright: Well, now, gentlemen, I regret that my time is more than up, and I suppose you will excuse me if I call upon the First Vice-President to take my place.

Mr. Black thereupon took the chair and said : You have all heard me speak a good deal, and I do not propose to make a speech. I thank you all for the honor you have conferred on me in electing me your First Vice-President. I have always had the interests of the Association at heart, and will do my utmost to further its interests in the future.

Mr. Thornton : I would like to move the usual grant to the Secretary of the Association. I think it is usual to do so, and it is a matter which should not be forgotten. I think it is $150.

Mr. Higman : I am very glad to second that motion.

Mr. Black : As the Secretary still has a little work to do, I will read the report of the committee appointed to draft the standing committees. If you wish to make additions or alterations, you are quite at liberty to do so.

Committee on Statistics—A. A. Dion, R. T. MacKeen, R. G. Black, Jas. Robertson.

Committee to Confer with Underwriters—K. B. Thornton, C. B. Hunt, J. J. Wright, W. C. Hawkins, Ed. A. Evans, A. A. Dion.

Committee on Legislation for Ontario—C. B. Hunt, A. A. Wright, B. F. Reesor, J. J. Wright, R. O. McCulloch, Gordon Henderson. For Quebec — A. Sangster, E. A. Evans, L. A. Denis, K. B. Thornton.

Special Committee for Advancement of Interests of Association—K. B. Thornton, R. T. Mackeen, R. G. Black, John Murphy, Louis W. Pratt, J. W. Purcell.

It was moved by Mr. Reesor, and seconded by Mr. Purcell, that the report of the committee be adopted. Carried.

Mr. Black: When the Legislative Committee brought in their report for the present year, they recommended that funds be placed at their disposal to defray the expenses for the coming year. It will be quite in order, therefore, for some one to move that the Executive have power to place at the disposal of the Legislative Committee such funds as they deem advisable to carry on the work.

Mr. J. J. Wright : I move that resolution.

Mr. Higman : I will second that. (Carried.)

Mr. Black : There is nothing definitely arranged about the Shawinigan trip, but it is well worth any one's time to go down.

Mr. J. J. Wright moved that the convention adjourn to meet in Niagara Falls in June, 1906.

OPERATION OF TRANSFORMERS AT VARYING FREQUENCIES AND VOLTAGES.

By M. A. Sammett.

The alternating current transformer holds a prominent place in modern Central Stations. In the investment of the plant it constitutes a considerable portion of the Companies outlay and where the supply of individual customers is done by the aid of step down transformers, the total kilowatt capacity in transformers is equal to three and even four times that of the capacity of the generating plant.

This wide application of transformers commands a thorough understanding of transformer characteristics and it is gratifying to note that of late manufacturing concerns are making an effort to disceminate useful information and thus place in the hands of the operating Engineer data which will enable him to have a more complete understanding of the various types of transformers, methods of testing same for losses, regulation, proper rating, etc., etc.

In view of the fact that the subject of testing has been dealt with in convention papers on previous occasions, I have in this instance selected a subject which will confine itself to characteristics expressing the effect of variable frequency and voltage on transformer operation. The choice of such characteristics suggested itself on the one hand by conditions peculiar to Hydroelectric power development so very extensive in Canada and on the other by the tendency of consolidation, a tendency of International character, aiming at the centralization of the same industries under one management.

Let us take up first the question of influence of variable frequency on the operation of transformers. In various Hydroelectric plants throughout the Dominion, wherever the severe winter generally causes a considerable diminution of the effective head on account of the ice formation in the tail race and forebay, the operating Engineer is sometimes called upon to resort to extreme means in order to carry the Station load at a lower frequency. Often Engineers laying out a plant for low water heads would, providing for such an exigency, specify the generators to be designed with a weak field and low magnetic density in the armature laminations. Then, when the emergency does come and there is no steam plant to fall back on for running the two plants in multiple and thus hold the entire system at the proper frequency the lower voltage, resulting from low speed will be raised by increasing the field excitation. Full normal voltage will be secured and as far as the generator potential is concerned normal conditions will be restored. Let us suppose there is a quantity of water sufficient to carry the load at a lower speed and investigate the effect of lower frequency on transformers intended to operate at a given higher frequency.

It would be impossible to give exact data as to how far it would be permissable to go in lowering the frequency of a given plant without endangering the very life of the apparatus of the system.

This would depend on the characteristics of the generators as well as the various transformers of the system. Granted that the generating machinery was designed to meet such conditions, would the same apply to standard apparatus such as step down transformers for lighting or motor service? What criterion can we use in order not to overstep the safety limit? As stated before, the individual characteristics of the apparatus must be known in every case in order to give a definite answer to this question and a treatment of general principles involved will serve to illustrate the relation between the frequency and transformer performance and to demonstrate their interdependence.

We shall not go into the minute analysis, but concern ourselves only with such points as are of interest to us as Central Station men, leaving the finer details to the designing Engineer.

The points in which we are chiefly interested are those of the affect on the iron losses, (the copper loss remaining practically constant at any frequency,) the exciting current and regulation, points that directly affect the efficiency of the apparatus and consequently the efficiency of the entire system. The difference of iron losses at different periodicities will affect the full load as well as the all day efficiency of the plant. The difference in the exciting current will be responsible for a considerably increased no load current.

We shall also determine the affect of lowering of the frequency on the regulation in order to find their relation. The question of regulation is an important one to Central Stations as the useful life of incandescent lamps depends altogether on the voltage of the circuit to which the lamps are connected and this voltage must be maintained constant requiring close regulation

To begin with, the first mentioned variable that of the iron loss is, as you all know, composed of the so-called Hysteresis or lag loss due to molecular friction caused by the lagging current of magnetic induction with relation to the magnetizing force as the iron goes through a cycle of magnetization, and the Eddy current loss, which is a loss of energy consumed in setting up induced currents in the iron.

Mr. C. P. Steinmetz, who carried on extensive investigations in connection with Hystersis and Eddy current losses, arrived at certain empirical formula which check very close with actual results and we shall make use of these formulae to get a clearer understanding of the relation between the various quantities which determine the iron loss.

HYSTERESIS LOSS.

In its simplest form the formula reads as follows:—

$$\text{Hysteresis} = P_H = xB^{1.6}$$

which is the loss in ergs per cycle for each cubic centimeter of iron. In this expression x is a constant indicating the quality of iron, depending on the chemical constituents entering it and also on the physical treatment in the manufacture of same. Applying the above expression to any transformer, in order to determine the Hysteresis Loss the formula will be modified by adding two more factors, namely, the volume of iron in cu. cms. and the factor representing frequency.

Hence

$$P_H = xVNB^{1.6} \text{ in ergs}$$

or if expressed in practical units

$$P_H = xVNB^{1.6} \times 10^{-7} \text{ watts.}$$

where x = Constant for given quality of iron.
V = Volume in cu. cms.
N = Frequency in cycles per second.
B = Induction per sq. cm. of iron.

EDDY CURRENT LOSS.

The energy lost in Eddy current reads as follows when expressed in practical units:—

$$P_E = EVN^2B^2 10^{-7}$$

where E = Eddy current constant.

V, N and B = volume, frequency and density expressed in the same units as those in the Hysteresis formula. The Eddy current constant "E" depends on the thickness of the laminations of iron and frequency, varying directly as the square of the thickness, the square of the frequency and directly as the first power of the specific Electric conductivity of the iron. Expressed numerically it reads:

$$E = \frac{(3.14)^2}{6} Z^2 y 10^{-9} = 1.645 Z^2 y 10^{-9}$$

where Z = Thickness in cms. of laminations.
y = Specific Electric Conductivity of iron in megohms

Hence

$$P_H = 1.645 Z^2 y V N^2 B^2 10^{-16} \text{ watts.}$$

The combined loss of Hysteresis and Eddy current generally called Core Loss will be expressed as follows:—

$$\text{Core Loss} = x\frac{VNB^{1.6}}{10^7} + \frac{1.645Z^2yVN^2B^2}{10^{16}} \text{ watts.}$$

Of these the Eddy current loss at commercial frequencies is the smaller one of the two and as it varies directly with the square of the frequency and induction, the higher the frequency and induction the higher the loss due to Eddy current. In standard transformers of good make the Eddy loss varies from 45 p. c. of the combined iron loss at 125 Cycles to that of 15 to 20 p. c. with a frequency of 25 Cycles.

Frequency	Hysteresis Loss	Eddy Current Loss.
125	55 p. c.	45 p. c.
60	70 p. c.	30 p. c.
25	80-85 p. c.	15-20 p. c.

In order to be able to calculate the change in the iron losses by the aid of the emperical formula given above we shall have to make use of the fundamental formula in alternating current work, the basic formula which expresses the relation between different quantities as they enter into the making of the transformer.

$$E = \sqrt{2} \cdot 3.14 \cdot TNAB\,10^{-8} \text{ or } B = \frac{E10^8}{\sqrt{2} \cdot 3.14 \cdot TNA}$$

where T = Turns of primary or secondary winding.
E = Voltage corresponding to turns of winding given above.
A = Cross section of iron in sq. cms.
B = Induction sq. cm

Having to deal with transformers in operation, all quantities with the exception of frequency and consequently magnetic density are fixed and we may combine them all under one constant

$$\frac{E10^8}{\sqrt{2} \cdot 3.14\ TA} = k.$$

This will reduce the formula to $B = k\frac{1}{N}$

Thus we see that magnetic density is inversely proportional to the frequency, that is to say, with a frequency half that of the original or normal frequency the density will be double normal density and with frequency twice as high as normal frequency we will have half normal induction, or with a change from 60 to 30 Cycles the induction will be double that it was at 60 Cycles.

Referring to formula of Hysteresis $P_{H60} = x \times V \times N \times B^{1.6} \times 10^{-7} = x \times V \times 60 \times B^{1.6} \times 10^{-7}$; when frequency is changed to 30 Cycles $P_{H30} = x \times V \times 30 \times (2B)^{1.6} \times 10^{-7} = x \times V \times (30 \times 2) \times 2^{0.6} \times B^{1.6} \times 10^{-7} = x \times V \times 60 \times B^{1.6} \times 10^{-7} \times 1.516$.

which means that a reduction in frequency from 60 to 30 will increase the Hysteresis loss 51.6 p. c.

The Eddy current loss in a given transformer, as will be shown by the equations below, is a constant loss, depending on the voltage alone. The two variables, namely frequency and induction, entering the expression as Squares of the inverse quantities, neutralize each other.

$$P_{E60} = \frac{1.645 Z^2 \times B^2 N^2 V}{10^{16}};\quad P_{E30} = \frac{1.645 Z^2 \times (2B)^2 (\frac{1}{2}N)^2 V}{10^{16}};$$

Hysteresis varying in the inverse ratio of frequencies raised to the power 0.6 we have the following relation.

New Hysteresis is equal to normal Hysteresis multiplied by

$$\left(\frac{\text{Normal frequency}}{\text{New frequency}}\right)^{0.6};$$

This expression will be helpful in enabling us to find the constants of conversion from existing frequencies to any new frequency.

Taking the Hysteresis at 133 Cycles as unity, we get the following constants of conversion:

FREQUENCY	HYSTERESIS	EDDY CURRENT
133	1.00	0.82
125	1.038	"
100	1.187	"
66	1.522	"
63	1.566	"
60	1.612	"
50	1.799	"
40	2.056	"
33	2.308	"
30	2.443	"
25	2.726	"

In this table the Eddy current loss is given as 82 p. c. of the Hysteresis loss at 133 Cycles and will remain a constant for all frequencies.

This table shows that a decrease in frequency will result in an increase in Hysteresis and consequently in a higher temperature of the transformer iron. In oil immersed as well as dry self cooling transformers this increased temperature rise of the iron will cut down the current carrying capacity of the transformers and what would under normal conditions be called normal load would with a lower frequency be an overload and may cause the burn out of the transformer.

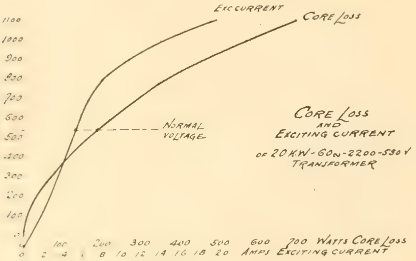


FIG. 1.

All standard transformers for lighting and motor service are manufactured so as to operate at a considerable range of frequencies and they are generally subdivided into two classes, "The High Frequency" and "Low Frequency Transformers." The former adopted for use on circuits from 60 to 140 and the latter from 40 to 140 Cycles. While they will be guaranteed to operate satisfactorily within the ranges given above they will have to be rerated as the various iron losses at different frequencies will increase the temperature at which the transformers operate, hence diminish their capacity. This consideration will add more weight to the importance of selecting transformers with a low core loss, a consideration so very vital for the all day efficiency of a plant with a heavy lighting load.

Taking up now the question of unification of two existing systems operating at different periodicities the conclusions arrived at in this paper would at once suggest that the lower frequency should be raised whenever possible and the higher frequency should be made standard. Such a change would decrease the energy dissipated in the iron of transformers of lower periodicity and they would operate at a temperature below that of previous normal conditions. While this policy should always be followed by Hydroelectric plants wherever conditions permit of such a change, it is of still greater importance to steam generating plants where high core loss resulting from lowering of the frequency, besides the fact of decreased transformer load carrying capacity, means also an increased coal consumption, two factors detrimental to the economy of the plant

Often, however, local conditions make it impossible to raise the frequency above a given point and then a compromise frequency would be the best way out of the difficulty.

We will now take the figures, given by one of the largest manufacturing concerns as guarantees of iron and copper losses of their standard transformers and applying the constants of conversion given in the table, determine the effect of a change from 60 Cycles to that of 40 Cycles.

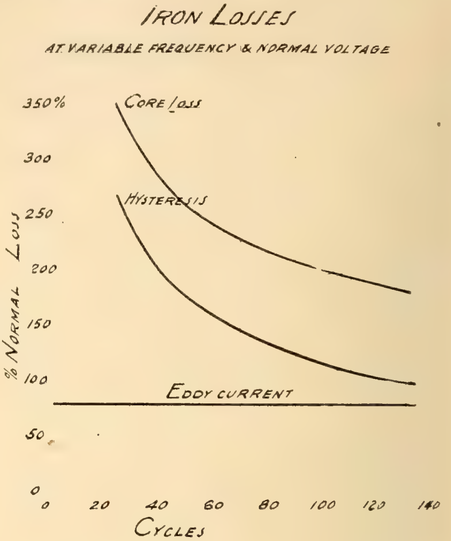


FIG. 2.

High frequency transformers 60 Cycles-2080-104-208 volts.

K. W.	Core Loss in Watts.	Copper Loss in Watts.	Total Loss in Watts.
1	39	27	66
3	62	65	127
5	95	94	189
7.05	117	125	242
10	156	147	303
15	202	215	417
20	232	290	522
25	258	327	585
30	302	394	696
	40 Cycles = 2 080-104-208 volts. K = 1.186		
1	46.5	27	73.5
3	74.0	65	139.0
5	113.0	94	207.0
7. 5	139.0	125	264.0
10	185.0	147	332.0
15	240.0	215	455.0
20	276.0	290	566.0
25	307.0	327	634.0
30	359.0	394	753.0

Thus we see that the lowering of the frequency from 60 to 40 will result in an iron loss of a 30 K. W. transformer of 57 watts higher than prior to the change and in order to keep the temperature within the same limits it would be necessary to decrease the current carrying capacity by the same number of watts. A reduction of 57 watts will bring the copper loss to 337 watts or to 85.5 p.c. originally normal copper loss and consequently to 92.5 p. c. of transformer capacity.

A change to a system of 30 Cycles will give the following losses:

K. W.	Core Loss in Watts	Copper Loss in Watts.	Total Loss
	K. – 1.34		
1	52.5	27	79.5
3	83.0	65	148.0
5	127.0	94	221.0
7. 5	157.0	125	282.0
10	209.0	147	356.0
15	271.0	215	486.0
20	311.0	290	601.0
25	346.0	327	673.0
30	405.0	394	799.0

Taking the same 30 K. W. transformer we find the Core Loss increased by 103 watts. A corresponding decrease in Copper Loss will reduce the latter to 292 watts or 74.1 p.c. normal copper loss, thus making the load carrying capacity of the transformer in K.V.A. only 86 p. c. that of normal.

The above figures giving the per cent. normal load capacity are favorable as compared to the large Station transformers which are designed with an iron loss considerably in excess of the copper loss, sometimes differing as much as to be twice the loss in the copper. You will readily see then that the capacity of the apparatus under these conditions would be greatly reduced with the increase in iron loss.

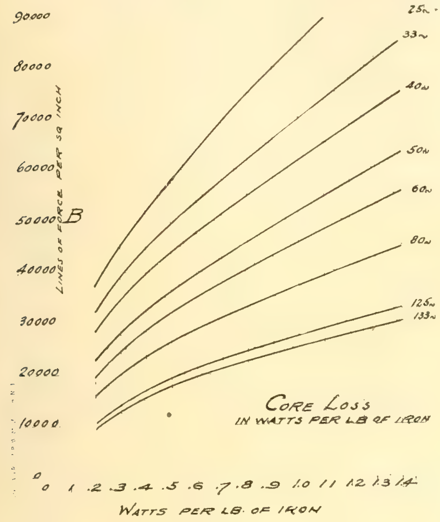


FIG. 3.

Assuming the Core Loss to be twice as high as the Copper Loss when operating at 60 Cycles what should be the transformer rating at 30 Cycles? Core Loss at 30 Core Loss at 60 x 1.34. (1.34 is constant derived from our table including both the Hysteresis and Eddy current losses.) This increase will make the energy dissipated in the iron 2.68x, where x is watts loss in the copper (instead of 2.00x) and the energy permissable to be dissipated by the coils to make up the same total energy loss of 3.00x for the same operating temperature will be 0.32x. The K. V. A. capacity varies directly as the square root of the energy lost in the winding. Consequently the transformer = capacity $\sqrt{0.32} = 0.565$ or 56.5 p. c. normal capacity.

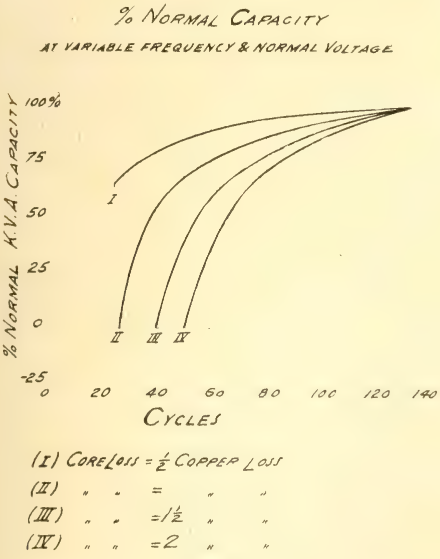


FIG. 4.

EXCITING CURRENT.

The exciting current is the vectorial sum of the magnetizing or wattless current and the energy current supplying the Hysteresis loss. The two components are at right angles to each other and the exciting current I can be expressed as $I_o = \sqrt{I_M^2 + I_H^2}$

where I_M = Magnetizing current

I_H = Hysteresis current

I_M in well designed transformers is equal to the Hysteresis current and this can be found by diving the Hysteresis watts into the impressed voltage.

Hysteresis watts as we have found before are equal to $P_H = xVNB^{1.6} \cdot 10^{-7}$;

giving for the Hysteresis current $I_H = \frac{xVNB^{1.6}10^{-7}}{E}$

The magnetizing current being equal in magnitude to the Hysteresis current, the exciting current will be equal to

$$1.41\,x\,\frac{VNB^{1.6}}{E10^7}$$

Thus we find the exciting current varies as the 1.6 power of magnetic induction, which in its turn varies inversly as the frequency. So that a lowering in frequency will increase the exciting current and naturally decrease the no load efficiency of the transformer as well as the entire plant.

REGULATION.

By regulation is meant the difference between the secondary voltage under conditions of load and with secondary coils open circuited, when a constant primary voltage is impressed. The regulation of a given transformer with a non-inductive load is so much different than the regulation when the load is inductive that it is essential to specify the nature of the load. It would be well to state here that in a given station operating Synchronons motors the lowering of the frequency would be prohibitive and even in the case of induction motors the change of speed cannot be allowed to fall more than 5 or 10 p.c. below the normal which is from 2 to 5 per cent. lower than the Synchronons speed. The only inductive load possible to be carried at frequencies below normal would be that of series alternating enclosed arc lamps. These operate as a rule at 60 Cycles, but will operate satisfactorily at 50 Cycles as is the case in many plants in Europe. 50 Cycles will serve as a limiting line, since at lower periodicities the arc becomes unstable. In incandescent lighting the critical point is reached at about 25 Cycles and therefore, plants operating at 40 Cycles may, other conditions permitting, drop in frequency to that point and yet give satisfactory service.

Confining ourselves to non-induction load only how would the regulation be affected with a frequency below normal?

$$\text{Regulation in \%} = 100\,\frac{[100 - \text{Secondary volts full load}]}{\text{Secondary volts no load}}.$$

Regulation when expressed in terms determining the various values in the transformer, can be expressed as follows:

$$\text{Regulation} = \frac{\sqrt{(100 + PIR + WIX)^2 + (IX)^2} - 100}{E}$$

where $(100 + PIR + IX)$ is the voltage in phase and IX is quadrature voltage.

P = Power factor = 100 with non-inductive load.

IR = Pr. + Sec. drop in %.

W = Magnetizing current in % of full load current.

IX = Reactive drop in %.

The values affected in this formula are those of magnetizing current, and reactive drop, resistance remaining constant at all frequencies, and since WIX is only a small fraction of one per cent., we are safe in saying that the change in regulation of a transformer operating at 60 to 30 Cycles will hardly exceed in well designed transformers more than 0.1 p. c.

The above discussion leads us then to the following conclusions:

A lowering of frequencies from 60 to 40 Cycles will increase our Core Loss 18.6 p. c. A lowering from 60 to 30 Cycles will increase it 34 p. c.

Transformer capacity will decrease in the first instance to 92.5 p. c. normal capacity, in the second to 86.0 p. c. In the case of large station transformers (oil immersed) where the iron loss is about twice that of copper loss, the capacity with a change from 60to 30 Cycles will be cut in half. With Air Blast transformers the capacity may be left unchanged when operated on a lower frequency provided the iron can be cooled effectively to keep them at normal temperatures.

The exciting current will rise with the falling off of frequency at about the same rate as the Hysteresis Loss. Regulation is affected but slightly, the lowering of the fre quency causing better regulation, but within 50 p. c. variation of frequency the difference will not exceed 0.1 p. c.

CHARACTERISTICS AT VARIABLE VOLTAGE.

We have seen how transformers would operate at a frequency different from the one they are intended for, and we shall now investigate as to the affect of variable voltage on the same apparatus.

Transformers when used at voltages lower than normal will have the benefit of a lower iron loss. It will be unsafe, however, to increase beyond a certain limit the ampere capacity of the transformer to compensate for the gain in Core Loss as the excessive current density in the copper may result in an abnormal rise of temperature in the winding, though the combined iron and copper loss are kept constant. The table given below is compiled on the assumption of a constant total loss and whatever gain was derived from a lower operating voltage was taken advantage of by allowing a larger load current. The capacity of the transformer was also calculated, but on purely K. V. A. basis without any allowance made for proper correction as to temperatures. It was assumed in this computation that the iron and copper losses are equal at normal voltage.

p.c. Normal Voltage	p.c. Normal Core Loss	p.c. Gain Core Loss	p.c. Normal Current	p.c. Capacity K.V.A.
10	2.5	97.5	140.5	14.05
25	10.9	89.1	137.5	34.4
50	33.0	67.0	129.2	64.6
75	63.0	37.0	117.0	87.75
100	100.0	0	100	100
125	149.0	49.0	71.4	89.5
150	191.0	91.0	3.0	4.5

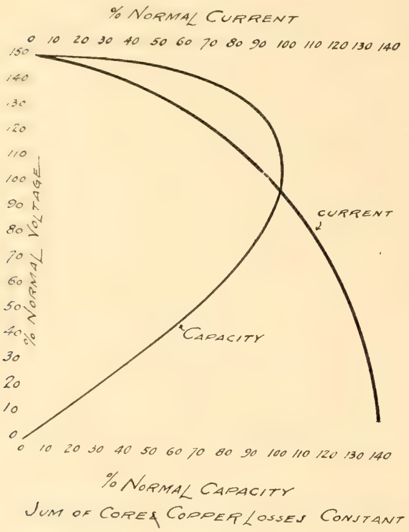


FIG. 5.

The figures and the accompanying curves show the capacity greatly decreased when the voltage differs from normal. With an increase of voltage 50 p.c. the Core Loss amounts to 95.5 p.c. of the combined copper and iron losses and when the transformer operates at 10 p.c. Normal voltage the copper loss is equal to 70.25 p. c. of the combined losses. In both instances the capacity in K. V. A. is greatly reduced.

CORE LOSS.

We shall refer once more to our fundamental formula

$E = \frac{\sqrt{2} \times 3.14 \times TNAB}{10^8}$ where T, N and A are constant values,

Hence calling $\frac{\sqrt{2} \times 3.14 \times TNA}{10^8} = k$ we get $E = k\,B$.

or at constant frequency, the magnetic induction varies directly as the voltage and since the Hysteresis varies directly with 1.6 the power of induction while the Eddy current varies directly as the square of induction, the Core loss will vary as some value between 1.6 and 2.0 of the induction depending on the frequency at which these transformers are operating.

Let us consider the frequency of 60 Cycles and find the multiplier expressing the relation between volts and induction.

From the table of constants of conversion of Hysteresis and Eddy currents, we find that the Eddy current loss constitutes 38 p. c. of normal Core loss. Hysteresis 62 p. c. of iron loss, varying as 1.6 power of induction and Eddy current 38 p.c. of iron loss varying as the square of induction.

An increase in say, 10 p. c. above normal voltage will cause a corresponding increase in induction. The hysteresis loss will rise by $(1.1)^{1.6}$; while Eddy current loss will rise by $(1.1)^2$.

Reducing the expression to a simpler form, we find the Hysteresis equal to 1.165 of the normal loss of 62 p. c. and the Eddy current equal to 1.21 of the normal loss of 38 p. c. or expressing it in times of core loss it will be 1.182 times the normal Core Loss.

The higher iron loss will reduce the current of the transformer for the same K.V.A. capacity, making the current 90.9 p. c. of the normal current and reducing the copper loss to 82.6 p. c. of normal loss.

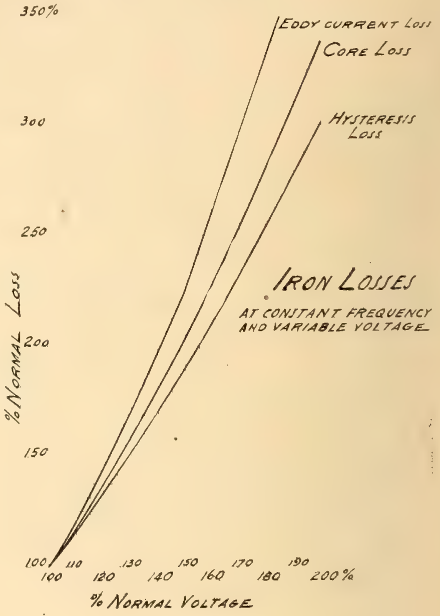


FIG. 6.

So we find an increased iron loss of 18.2 p. c. to be accompanied by a decrease in copper loss equivalent to 17.4 p. c. The iron loss being larger than the gain in copper loss by 0.8 p. c. the all day as well as full load efficiency will be somewhat less.

An increase in 20 p. c. above normal voltage will affect the transformer as follows: —

Hysteresis will increase 34.0 p. c.
Eddy current will increase 44.0 p. c.,

and the combined loss will increase 37.8 p. c. For the same K.V.A. the current in the coils will be only 83.3 p. c. of normal and the gain in copper loss resulting from same will be 30.6 p. c. The excess of the increased iron loss over the gain in copper loss amountsto 7.2 p. c. which makes the increase in voltage of 20 p. c. prohibitive. Besides the question of excessive Core Loss, the excessive exciting current will enter in consideration as well as the diminished factor of safety in the insulating material will have to be contended with.

A decrease in 10 p. c. of normal frequency will give us the following per cent. of gain and loss.

Core loss will be decreased to $0.90^{16} = 84.5\%$ Normal Hysteresis, $0.90^2 = 81\ 0\%$ Normal Eddy Loss.

The combined iron loss amounting to 83 1 p. c. Normal Core Loss, or a gain of 16.9 p. c. and the copper loss increasing 21.0 p. c. This condition is not as favorable as an increase in voltage by the same amount. Thus we see that a change of 10 p. c. above the voltage the transformers are designed for will allow satisfactory operation and increase the total loss by 0.8 p. c. affecting the result as to the efficiency of either the transformers or the plant but very slightly, while a higher change in voltage will affect the efficiency of the apparatus as well as its rating to a considerable degree. Taking the same guarantee losses as those discussed under the heading of the affect of variable frequency and correcting same by the factors given above we get the following losses:

CORE LOSS.

Normal conditions, Losses as guaranteed.
60 Cycles — 2080 — 104-208 Volts.

K. W.	Core Loss in Watts in Watts	Copper Loss in Watts. in Watts.	Total Loss
1	39	27	66
3	62	65	127
5	95	94	189
7.5	117	125	242
10.0	156	147	303
15	202	215	417
20	232	290	522
25	258	327	585
30	302	394	696

Computed losses. Voltage 10 p. c. above normal

1	46	22.5	68.5
3	73	54	127.0
5	112	78.0	190.0
7.5	138	103.0	241.0
10	184	121.5	305.5
15	238	177.5	415.5
20	274	239.0	513.0
25	305	270.0	575.0
30	355	325.0	680.0

Voltage 10 p. c. below normal

1	32.5	33.0	65.5
3	51.5	79.0	130.5
5	79.0	114.0	193.0
7.5	97.0	153	250.0
10	130.0	178	308.0
15	168.0	260	428.0
20	193.0	351	544.0
25	214.0	396	610.0
30	251.0	477	728.0

Voltage 20 p. c. above normal

1	4	19.0	73.0
3	85.5	45.0	130.5
5	131.0	65.0	196.5
7.5	161.0	87.0	248.0
10	215.0	102.0	317.0
15	278.0	149.0	427.0
20	320.0	201.0	521.0
25	356.0	227.0	583.0
30	417.0	274.0	691.0

Voltage 30 p. c. above normal.

1	62.0	16.0	78.0
3	98.0	35.5	133.5
5	150.0	55.5	205.5
7.5	185.5	74.0	259.5
10	247.0	87.0	334.0
15	320.0	127.0	447.0
20	368.0	171.0	519.0
25	409.0	193.0	602.0
30	479.0	232.0	711.0

Voltage 50 p. c. above normal

1	79.5	12.0	91.5
3	127.0	29.0	156.0
5	194.0	42.0	236.0
7.5	239.0	55.5	294.5
10	318.0	65.0	383.0
15	412.0	95.0	507.0
20	473.0	129.0	602.0
25	526.0	145.0	771.0
30	616.0	175.0	

Voltage 100 p. c. above normal.

1	133.0	7.0	140.0
3	210.0	16.0	226.0
5	325.0	23.5	348.5
7.5	400.0	31.0	431.0
10	530.0	37.0	567.0
15	686.0	54.0	740.0
20	790.0	72.5	862.0
25	877.0	81.5	958.5
30	1030.0	98.5	1128.5

While small standard transformers may be easily put on a circuit of double voltage, the apparatus in larger sizes is often designed at considerably higher induction and double voltage impressed on the transformer will even with the transformer secondary open circuited take a considerable load, the iron being pretty well magnetically saturated.

The difficulty of dealing with saturated iron on over-potential test becomes very pronounced when manufacturers undertake to build apparatus which they guarantee to withstand a triple potential across the transformer coils.

At an acceptance test witnessed by the speaker, the manufacturer, endeavoring to demonstrate the safety of the apparatus at triple normal voltage, resorted to a high frequency machine, which was a 133 Cycle machine speeded up to 165 Cycles, and then succeeded in impressing only double voltage. The high speed of the alternator caused an excessive armature reaction and the demagnetized alternator field would not generate a voltage high enough for the test.

The transformers were of the Air Blast type, 1100 K.W., the high frequency alternator running at 165 Cycles and while reducing greatly the Hysteresis loss increased the Eddy current loss on account of the increased frequency.

Let us get at the actual figures in this particular instance. The transformer as stated was to operate at 60 Cycles. Core Loss at normal voltage was equal to 11.000 watts. If 62 per cent. of this loss is Hysteresis and 38 per cent. Eddy current, the iron losses will be 6,820 and 4,180 watts respectively. With an increase of frequency to 180 and a rise in voltage to three times normal, the Hysteresis loss will come to 22,700 watts, as against the original Hysteresis loss of 6,820 watts. And the Eddy current loss at same potential will be 37,200 watts, as against 4,180 watts. Total loss in the iron amounting to 59,900 watts.

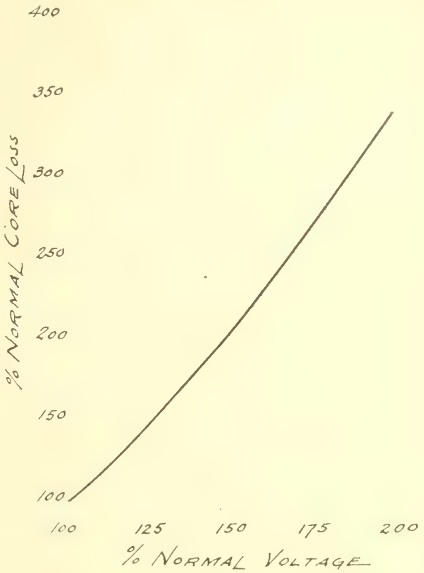


Fig. 7.

This example is made mention of as an extreme case to illustrate more vividly the behavior of transformers at a voltage much in excess of normal voltage.

EXCITING CURRENT.

With increased voltage there will be an increased exciting current in consequence of a proportionally larger induction.

$$\text{Exciting Current} = 1.41\,K\,\frac{B^{1.6}}{E}$$

Since B varies directly as E any increase in voltage will increase the exciting current. With a constant frequency this increased current will be smaller for the same change as expressed in per cent.., when compared with the increase at variable frequency and constant voltage.

For instance a change in voltage of 20 per cent. above normal will increase the exciting current, making it

$$K\frac{(1.2B)^{1.6}}{1.2E} = K\frac{B^{1.6}}{E}\cdot\frac{1.2^{1.6}}{1.2} = 1.11\,K\frac{B^{1.6}}{E};$$

or an increase of 11 per cent. While a change in frequency amounting to 20 per cent. will affect the exciting current by as follows:

$$K \times .80\,N \times (1.25B)^{1.6} = 1.148\,KNB^{1.6};$$

an increase of 14 per cent.

REGULATION.

A voltage different from that of normal not to be detrimental to the operation of synchronons and induction motors must not exceed much that of normal voltage. We shall therefore confine ourselves to a change of 10 and 20 per cent. and see how this would affect regulation for both non-inductive and inductive load. Wherever there is a motor load a reduction in voltage would not be advisable.

$$\text{Regulation} = \frac{\sqrt{(100 + PIR + IX)^2 + (IX)^2} - 100}{E}$$

Non-inductive load. Voltage 10 per cent. above normal.

An increase in voltage 10 per cent. will decrease the current to 90.9 per cent. normal, IX will decrease to 90.9% and WIX = 100.8%.

Hence

Regulation will be improved.

INDUCTIVE LOAD.

$$\text{Regulation} = \frac{\sqrt{(100 + PIR + WIX)^2 + (PIX - WIR)^2} - 100}{E}$$

An examination of this formula will show at a glance, applying the correcting factors to the various quantities, that the regulation will be improved by raising the voltage 10 or 20 p. c.

TO RECAPITULATE

A higher voltage amounting to 10 or 20 p. c. will not affect the losses materially except that the increased Core loss will reduce the all day efficiency of the transformers. This difference in the instance of 10 p. c. rise will amount to 0.8 p. c. and at 20 p. c. rise higher losses will result in higher heating on account of increased, Core Loss and danger of break down, due to higher voltage.

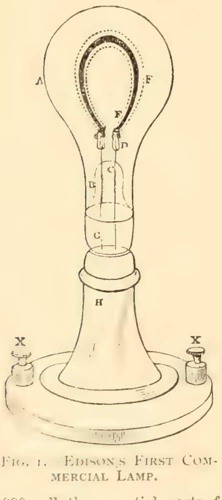
A lowering of 10 p. c. will result in an increased all day efficiency but will reduce the full loss efficiency as well as cause the transformer to run hotter.

The exciting current will increase with increased voltage, thus making the no load current feeding the transformers larger. The Regulation at either non-inductive or inductive load will be improved.

SOME NOTES ON THE INCANDESCENT LAMP.

By A. B. Lambe.

Contrary to what would seem to be the understanding of many electric lighting Companies, the subject for our consideration this evening, the Incandescent Lamp, is one of the most important pieces of apparatus which they are called upon to use and consider, because after all is said and done it is the end and object of the most costly and well planned systems of engines, lines and transformers, more than this it is that part, and practically the only part, of the system in view of both present and prospective customers, and therefore the one by which both the Company and the service it offers are judged. It is remarkable in many ways, not the least of which is that it was practically a perfect piece of mechanism when first designed, containing in Edison's original form, shown in Fig. 1, reproduced from an issue of the *Graphic* dated about 1880, all the essential parts found in the latest product of the present day. It has survived many changes in methods of generation and distribution, has given equal satisfaction on both alternating and direct current, has adapted itself to potentials of 200 volts and higher, has kept pace with all reductions in frequency, and forms to-day the mainstay of central station revenue. It consists essentially of a conducting medium, the filament, which gives out the light, a glass bulb to keep air away from the filament so that this latter will not burn away so quickly as it otherwise would, and the base, the function of this being both to form the electrical connection between the filament and the supply circuit and to hold the lamp in position. Before however discussing these different parts it is perhaps desirable to first consider the question of light and its measurement, the production of light being the main field of the incandescent lamp.



A. The Vacuum Globe. B. Interior Glass Crest, through which wires pass to light. C. Platinum Wires. D. Platinum Clamp. E. Carbonized Cardboard. F. Dotted Line, showing size of Incandescence equal to Sixteen Candles. G. Copper Wire to Meter and Generator. H. Wooden Stand. X X. Binding Posts.

Fig. 1. Edison's First Commercial Lamp.

Light being a saleable article there immediately arises, as with all other commercial commodities, the necessity for a set of units as a common basis for comparison and measurement. These are three in number, viz.: The Unit of Light, which is known as the Candle Power; the Unit of Illumination, the Candle Foot; and the Unit of Intrinsic Brightness, which is generally accepted as one Candle Power per Square Inch. The first refers to the source of light and the amount which it can emit, the second to the illumination of any specified surface, and the third to the relative brightness of the source of light, that is, assuming a given candle power, as to whether the luminous surface is relatively large, in which event the intrinsic brightness is low, or whether it is comparatively small, which means high intrinsic brightness. A detail consideration of this factor, besides requiring too much time, is somewhat outside the limits of our subject, but the following table from Dr. Louis Bell's "Art of Illumination" will be interesting:

INTRINSIC BRILLIANCIES IN CANDLE POWER PER SQUARE INCH.

Source.	Brilliancy.	Notes.
Sun in Zenith	600,000	Rough equivalent values taking account of absorption.
Sun at 30° Elev	500,000	
Sun on Horizon	2,000	
Arc Light	10,000 to 100,000	Maximum about 200,000 in crater
Calcium Light	5,000	
Nernst "Glower"	1,000	Unshaded.
Carbon Incandescent Lamp	200-300	Depending on Efficiency.
Melting Platinum	130	1 square cm = 18.5 c.p.
Enclosed Arc	75-100	Opalescent inner globe.
Acetylene Flame	75-100	
Welsbach Light	20 to 25	
Kerosene Light	4 to 8	Very variable.
Candle	3 to 4	
Gas Flame	3 to 8	Very variable.
Carbon Incan. Lamp (Frosted)	2 to 5	
Opal Shaded Lamps, etc.	0.5 to 2	
Tantalum Lamp	500	

In England and on this Continent the Candle Power is the light emitted by a candle which weighs one-sixth of a pound and consumes 120 grains of spermaceti per hour, being known as the English Parliamentary standard. On the Continent and

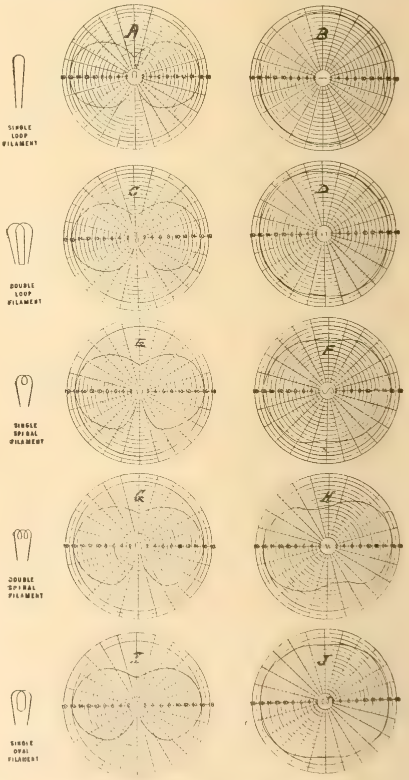


Fig. 2. Distribution of Light From Different Types of Filaments. The Left Hand Curves Show the Distribution in a Vertical Plane, Those at the Right the Corresponding Horizontal Distribution.

in some other parts of the globe they consider as standard the Hefner amyl-acetate lamp, which gives a light 88 per cent. that of the other.

The Candle Foot is defined as the direct illumination given by a standard candle placed one foot away from the object illuminated. At other distances the illumination is determined by what is known as "The Law of Inverse Squares," which states that the intensity of any light varies inversely as the square of the distance from the source. Thus if we have an object lighted by a 16-c.p. lamp placed a foot away, the illumination is 16 candle feet, if two feet away it is reduced to four candle feet, and so on. For ordinary reading and writing an illumination of one to two candle feet is usually satisfactory. It should be noted that this law of inverse squares holds only in cases free from refraction or reflection, which as a rule are very rare.

The unit in incandescent lighting is the 16 c.p. lamp, this being the size which is most carefully proportioned and highly developed, and which forms by far the largest percentage of present-day consumption. The derivation of what would seem to be the rather peculiar figure of 16 is interesting, it is that as the incandescent lamp when it first came on the market had to compete with the illuminants already in use, gas and oil, it was naturally advisable to make it equivalent to them; tests showing that they gave about 16 c.p., the newcomer was also made of this value. Having a standard we must have means of perpetuating it, and this is accomplished by the use of standard incandescent lamps, made of low efficiency so that they will change but little with use, and which, after seasoning, are very carefully calibrated, that is, the voltage at which they will give their rated candle power determined down to a very fine point. Standards are made on this continent, in addition to the various lamp manufacturers, by the Lamp Testing Bureau of New York City, now an independent company, though at first an organization controlled by the users of Edison lamps. Besides the Lamp Testing Bureau there is the German Richenstahlt, a Governmental institution in Berlin, Germany, which is probably the highest light authority in the world.

Light is measured by an instrument called a Photometer, the principle of which is—without having space for any detailed description—that the light from the source under measurement is balanced against that from a standard by shifting backwards and forwards a traveller containing the necessary arrangement of a shadow producing object—usually a grease spot—and mirrors to transmit the two shadows to the operator's eye. The position required of the traveller to make the shadows equal determines the relative candle power of the two lamps.

Seeing that the major part of the light is given out at right angles to the filament surface it is evident that different types of filaments will give different distributions of their light, that is, though the total from two lamps may be the same, their respective illuminations of a given point may be very different. In order to determine the distribution from the different types of filaments many readings have been made on the various forms and the results plotted on curves as the most satisfactory method of displaying and using the results. Such a series is shown in Fig. 2, which covers both the horizontal and vertical distribution of the filaments in more general use, I, the single oval form, being that found in the great majority of lamps, hence its name of regular type. From this curve you will notice that the 16 c.p. lamp of this form gives a tip or end light of about 7 c.p., while up above there is practically none. In diagram G are found the vertical plane results from the double spiral type of filament, and while this gives what it is designed for, a larger tip or end light, you will see from curve H, which shows its horizontal plane distribution, that the candle power from this form varies considerably as you walk round the lamp. As compared with this, curve J, which is the horizontal result from the single oval, shows the latter's distribution in this plane to be much more uniform. This is quite an important point and one which should not be overlooked in choosing your type of lamp, another advantage is that the relatively larger side light is an aid towards obtaining more even illumination between lamps. From these curves you see how materially the distribution is changed by varying the shape of the filament; besides this it can be altered by the use of reflectors, which, by shaping them in the proper manner, can be made to concentrate or diffuse as desired. These two factors, the shade and the special type of filament, alone or in combination, form the basis of all such lamps as the Shelby, Sunburst, Zenith, and Meridian, or any other types designed to give a special distribution of their light. Fig. 3 is typical of the vertical plane distribution of this latter class. It is interesting to note that frosting also changes the distribution somewhat, decreasing the horizontal and increasing the tip candle power, though, contrary, to popular impression, it does not cut off much light, only 3 or 4 per cent., or about half a candle on a 16 c.p. lamp.

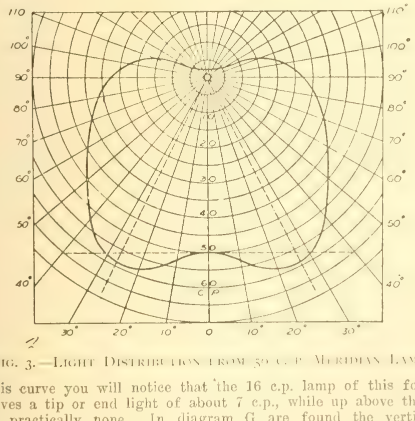


Fig. 3.—Light Distribution from 50 c. p. Meridian Lamp.

When comparing lamps of different types it is not satisfactory to measure the candle power in one direction only, because, even with all showing the same light when viewed from some given point, the light in other directions, and therefore the total light emitted, may vary considerably. This means that the lamps vary in efficiency, so that they cannot be expected to give the same life even if they all consume the same total wattage. Thus when comparing lamps of different types you must get a common basis for comparison, and this is found in what is called "Mean Spherical Candle Power," or the candle power a lamp would give if radiating an equal amount of light in all directions. It is the average of all the measurements forming any one of the left-hand curves shown in Fig. 2, the light measured along the horizontal lines being horizontal candle power. The relation between the two of course varies considerably with the different types of filaments; to obtain it you may either go to the trouble of plotting curves such as these or you can use the correction factors shown in Fig. 4, which have been deduced from many extensive experiments. This point of average spherical candle power is most important and one worthy of repetition, viz: You must when comparing lamps of different types bring your measurements to the common basis of mean spherical and not horizontal candle power, otherwise your results are entirely wrong and most unfair to one lamp or the other.

Type of Filament See Fig. 2.	Horizontal W.P.C. at which to test various lamps to bring them to the same basis as the Single Oval filament.
Single Oval	3·5
Single Spiral	3·5
Double Spiral	3·52
Single Loop	3·41
Double Loop	3·415

Fig. 4.—Factors for Use When Making Life Tests on Filaments of Different Types.

Another method of tabulating the results from lamp measurements is contained in Fig. 5, which shows a diagram that takes account of not only the candle power emitted but also of the total watts consumed. It is known as a "shot gun" or target diagram, and being very convenient is used to record nearly all candle power and wattage tests. The reading of each lamp in candle power and volts is shown by a dot, the heavy lines in the centre marking the extreme candle power

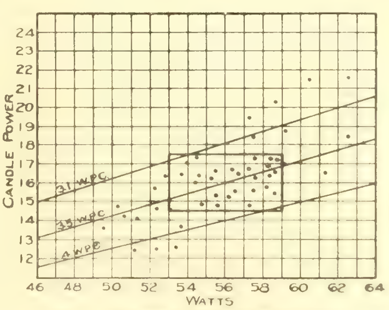


Fig. 5.—Target or Shot-Gun Diagram.

the wattage limits permitted by the particular specifications under which you may be working; as such the space enclosed may be called the test or specification area. The inclined lines show the efficiency. The point to be particularly noted is that a lamp low in total watts is not necessarily of high efficiency, because it may not be giving its rated candle power. This should prevent us falling into the frequent error of thinking that, because a lamp is of low total watts and yet gives a longer life than another which consumes more energy, it is the better lamp. You must measure the candle power as well as the wattage; frequently the lamp which is low in the latter is even worse as regards its light giving properties, obviously it is then of low efficiency and incorrectly rated, yet must of necessity give longer life than the more accurately measured product.

Unless otherwise specified an incandescent lamp is always measured horizontally, that is with the lamp vertical, and revolving at 180 R.P.M., horizontally to match gas and oil flames which have to burn vertically and thus give practically all of their light in the other direction, and revolving because, as you have already seen from the right-hand curves in Fig. 2, particularly H, the light varies according to the position from which the filament is viewed; revolving the lamp tends to eliminate this variation. It should be noted that the light from any given lamp is not a fixed quantity unless the voltage also be fixed, because raising or lowering this latter means a corresponding or rather an even greater percentage alteration in the former. For instance one volt change in the potential on a 100-130 volt 16 c.p. lamp will make about one candle power difference in the light, and a corresponding variation in other sizes. This can be put in another approximate rule, viz., that the candle power percentage change is about five to six times that of the voltage, Fig. 9 showing the results in detail.

The foregoing is a brief outline of the method of measuring, tabulating, and comparing the light from incandescent lamps. Next in order come their mechanical features, which can conveniently be discussed under the headings of Filament, Stem, Base, and Bulb.

FILAMENTS: While platinum has been tried for use in filaments it has not proved nearly as satisfactory as carbon, which is the material in general use to-day. On the other hand the work of the last year or two seems to indicate that we are now in a fair way towards getting commercial filaments from some of the more refractory metals, such as osmium and tantalum. Should this turn out to be the case we will then be able to operate at efficiencies of 1½ to 2 w.p.c. as compared with the 3 to 4 w.p.c. limit of to-day, in other words the light capacity of your plant will be doubled. Carbon filaments are obtained from three sources—cellulose, silk, and bamboo—the two latter being used for the large conductors required by high amperage lamps, and cellulose for practically everything else. The process of manufacturing the latter is naturally most intricate and more or less a trade secret. In outline it is first to make a pulp from filter paper or absorbent cotton, the basic materials, after which the mass is dissolved in a solution such as chloride of zinc and then partially evaporated. Next it is squirted through a very fine aperture, which produces the thread-like form, immersion in alcohol serving to harden it. After this it goes through a variety of treatments before assuming its final shape, the principal being that known as flashing or treating. This consists in electrically heating the filament while surrounded by a hydro-carbon gas, the result being the decomposition of the latter, the constituents of which deposit themselves on the filament and unite with it. Previous to this stage these latter occasionally contain high resistance spots, due partly to small diameters and partly to a difference in composition. These naturally get hotter than the rest of the filament, which in turn means a heavier deposit there than elsewhere, and as this depositing or plating has the effect of reducing the resistance it will thus be seen that any high resistance spots are automatically brought to the same conductivity as the rest of the filament, in other words the process makes these latter as far as possible of the same characteristics throughout their whole length. Another electrical effect besides evening the resistance is to reduce it throughout to quite a marked degree, so much so that in some high volt and some low candle power lamps, where a high resistance filament is a natural necessity, treating would bring it below the permissible point, which means that in these cases an untreated filament has to be used. Another effect of this process is to turn the filament from a dull dead black to a smooth steely gray, this forming a comparatively easy means of distinguishing between the treated and untreated types. At this point it is valuable to note that, efficiency candle power and type of filament remaining constant, the higher the voltage the smaller the filament, because the higher the voltage with a given total watts the smaller must be the amperage, if you reduce the amperage you must also reduce the size of your conductor if you are going to get the same degree of heating, and you must have the same heating if you want to keep the efficiency the same. From the foregoing it also follows that, in each case the other three terms remaining constant, the smaller the candle power or the higher the efficiency, the smaller is the filament. As a smaller filament is obviously weaker mechanically than one of larger cross section it follows that lamps of high volts, low candle power, or high efficiency, are relatively more fragile, both electrically and mechanically, than those possessing opposite characteristics. It is scarcely practicable to make carbon filaments for candle powers greater than one candle power per volt, particularly in the smaller sizes, no lamps are made for less than 3 volts, and 150 candle power is about the largest lamp desirable.

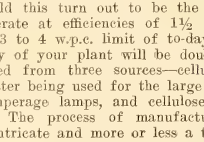


Fig. 6.—Locking Adapter.

THE BASE: In the earlier days almost every manufacturer had his own base; in Europe somewhat the same state of affairs prevails to-day. Over here we some time ago settled down to three types—Westinghouse, T. H., and Edison—of which the latter is to-day being standardized by practically everybody. This result is being aided very largely by the introduction of the locking adapter, shown in Fig. 6, which is a new form of this little device that locks into a T. H. socket so that it cannot be withdrawn, thus permanently changing it to the Edison type. We can therefore expect that in a comparatively short time there will be nothing but the Edison socket in use throughout this continent. The benefits of this standardization, which affects not only the lamp itself but also the many different sockets and receptacles in use to-day, will be apparent to everyone.

STEM: The Stem or Stem Tube, shown in Fig. 7, is that part which contains the leading-in- wires, and is of course made of glass. The lead wires are of copper except for a small part of their length at the end where they pass through the glass, at this point a small piece of platinum is put on, the object being to make an air-tight joint, glass and platinum having the same coefficient of expansion. At the same time as the leading-in- wires are put into place the anchor is put in. This is usually of nickel-plated iron wire, its function being to steady the filament so that it will not be so liable to breakage from excessive vibration or from touching the glass when hot. When the stem has had the filament mounted on to the platinum tips, for which purpose a carbon paste is used, it is called the mount, and as such is ready for insertion into the bulb.

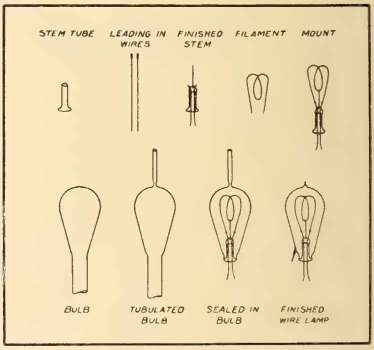


Fig. 7.—Lamp Parts.

THE BULB, shown in various stages in Fig. 7, is made of a very fine quality of glass, clear or colored as required, and one absolutely free from cracks or other flaws. It is extremely thin, about 1-100 of an inch, nevertheless it will stand quite a blow, and very successfully resists ordinary atmospheric pressure, which figures out on such a lamp as the 50 c.p. Meridian to about 125 pounds total. For special service under extra high pressure, such as that encountered in diving, or extra high temperature, like that in a baker's oven, it is frequently desirable to use a somewhat heavier glass.

The regular type lamp has a straight sided bulb in the medium voltage and candle power classes. For decorative work and mechanical processes there is an almost unlimited number of special shapes and sizes, such as the round bulb, candelabra, bung-hole or candle, telephone, etc., etc.

When the bulbs are received from the glass manufacturers they have the appearance shown in the first form illustrated in Fig. 7. The first operation is to put the exhaust tube onto the large end and then cut off the neck to the required length; they are then known as tubulated bulbs. Next the mount is inserted through the neck and the joint between the bulb and the flare of the stem tube is sealed. The lamp is then exhausted by means of a vacuum pump, and is sealed off when that process is completed by heating the exhaust tube at a point close to the bulb, which leaves the familiar tip found on all lamps exhausted from this end. Lamps are sometimes exhausted at the other end, but the process is expensive and as a rule the trade will not stand the extra cost involved. You now have what is called a wire lamp and in that state it is ready for testing and basing, and then labelling and shipping.

There are, of course, numerous tests and inspections which a lamp has to go through both before and after the operations described above, the most important perhaps are those for vacuum, spotting, and voltage. The Vacuum Test is made by connecting the bulb and filament to the terminals of a powerful induction coil, the color and intensity of the resultant discharge between the filament and glass being a measure of the vacuum—practically no discharge indicating O.K., conversely a heavy discharge means a poor vacuum. Spotting is a test, as its name indicates, for spots in the filament. These arise from incomplete flashing, this latter operation occasionally failing to remove all the high resistance points, provided any such were originally present. When any of these still remain their natural tendency is to get hotter than the balance of the filament and thus to cause a quick burn out. However, by running the lamp at a low voltage so that the filament is only a dull red, they can be detected by an experienced eye and the lamp thrown to one side. The Test for Voltage consists of a photometer reading to find at what potential the lamp will give its rated candle power. At first sight it might be thought unnecessary to read but a small percentage of the lamps in each particular batch—just the same as you make a few briquettes of a certain run of cement or take occasional test pieces from the iron you are pouring—but such is not permissible because it is not known to the present state of the art how to make a filament come exactly to the desired rating; as a consequence you have to photometer every lamp you manufacture and find the actual voltage at which it will give the candle power for which it is designed. Assuming that you are working on the 16 c.p. 110 volt class besides obtaining these you will find a number of lamps in any given lot that will come 107, 108, 109 volts, and others 111, 112, 113 and 114; similarly the 104 volt class will produce say 100 to 108 volt lamps. Now this means that every lamp manufacturer must inevitably produce voltages ranging from say 100 to 130 volts, even though he try to make nothing but those for which the demand is greatest, say 104, 110, 115, 120 and 125 volts. Seeing then that production exists there must also be consumption in some way or another, and so that manager is wise who selects for his plant some potential other than 104 and 110, which apparently have got such a hold on the trade in this country. The advantages to the consumer are that he will on the average get a more closely selected lamp, obtain better deliveries, and, if he will go over his circuits and find the actual average potential and then use that voltage of lamp, better life and candle power results. This latter almost invariably turns out to be the case, because as a general rule such an inspection with a reliable instrument will reveal that the actual potential is considerably away from what it is supposed to be. If it turn out to be low your customers are not getting the light to which they are entitled, if high your lamps are being darkened and burnt out in far shorter time than should be the case.

There next comes up for our consideration the question of Operation or Lamp Service; it can most conveniently be discussed under the headings of Efficiency, Life, Trouble, and Renewals.

EFFICIENCY: This is the relation between the power consumed and the light produced, and is expressed by the term "Watts per Candle," usually written "w.p.c." High efficiency, that is, small energy consumption, simply means that you are burning your filaments at a comparatively high temperature; naturally this in turn means that that filament must give way sooner than one of lower efficiency, which is one operating at a lower degree of heat, in other words the higher efficiency lamp always has a shorter life under any given set of conditions than one which, while giving the same amount of light, does so at the expense of more energy, that is one of lower efficiency. Again, the higher the efficiency the shorter the life on mechanical grounds, as discussed in the last paragraph on filaments.

In the regular type medium voltage and candle power classes there are three standard efficiencies, 3.1, 3.5, and 4 w.p.c., or 49.6, 56 and 64 watts total per 16 c.p. lamp. The reason for the existence of different efficiencies will be evident when we recollect that the cost of light consists of two distinct factors—the cost of the lamp itself and that of the energy to operate it. Obviously, when your fuel expenditure is a minimum, as under such conditions as cheap coal, blast furnaces gases, a market for all your exhaust steam, water power, etc., etc., the low efficiency lamp will bring the light cost to a minimum; on the other hand heavy power costs make the high efficiency equipment the cheapest in the end. As a general rule the 4 watt lamp is too wasteful to merit consideration, and so unless your regulation is very poor you are confined to a choice between the other two. Assuming a life of 400 hours for the 50 watt and 800 hours for the 56 watt lamp, it will require two of the former to give the same life as the latter; they will save, however, 6.4 watts per hour, or for the 800 hours a total of 5.12 K.W. hours. Against this saving must be put the cost of an additional lamp, and assuming this latter at 17 cents it is evident that they exactly balance each other when 5.12 K.W. hours of power cost you 17 cents, or in other words, when power costs you $17 \div 5.12 = 3.32$ cents per K.W. hour. If your actual cost is less the 3.5 watt lamp is the cheaper, if more then the 3.1.

It must be noted that this method of figuring does not take into consideration the increased lamp capacity of a plant resulting from the use of a higher efficiency lamp, the fact that the higher the efficiency the sooner does the lamp burn out after it has got black, thus automatically ridding your system of lamps which are ready for the scrap pile, nor again that the higher the efficiency the better the quality of the light, that is, the greater its brilliancy or intensity and its whiteness. This difference in lights of equal candle power but from different efficiency lamps is frequently a source of contention, more particularly when working on colors than when dealing with black and white. The higher efficiency lamp *looks to be giving more light* than that of lower wattage, but this cannot really be so if they are of the same candle power, it is simply that the more pleasing quality is deceiving the eye into thinking that it is of greater quantity.

The efficiencies referred to above are those when a lamp is new; as it burns the candle power declines, and taking for illustration the point where it has fallen 20 per cent. we find that the wattage consumption during the same period has decreased approximately only 5 per cent., obviously the w.p.c. have changed very materially. This new efficiency obtained at the end of the life is known as Terminal Efficiency, that at the beginning is Initial Efficiency, the mean of the period in between is the Average Efficiency. Unless otherwise specified the initial efficiency is always the one considered, and is spoken of simply as the efficiency.

THE LIFE OF A LAMP, that is, its ability to continue giving light, is affected by a great many factors, such for instance as the voltage and candle power class to which it belongs, and again by the actual voltage at which it is operated, but before discussing them we should establish the meaning of the word, which in lamp practice can cover two distinct terms. In the first place you have the hours burning until the filament breaks down and the lamp refuses to burn any longer; this life to the burning out point is called the Average Life. Again you meet another condition which can best be described as follows, viz.: Taking a 16 c.p. 56 watt lamp left on the circuit until it burns out, we find that just before that point is reached it is giving say only 8 c.p., while the watt consumption has fallen but to 50 watts, or an efficiency of over 6 w.p.c. Now if 8 c.p. is sufficient light is it not obviously preferable to put in an 8 c.p. lamp, which will not only give that light for but 60 to 70 per cent. of the energy consumed by the old 16, but will also give you a light that will be of a 4 w.p.c. quality instead of worse than 6. From this we see that there is a point in the life of the lamp at which it is both economical and otherwise desirable

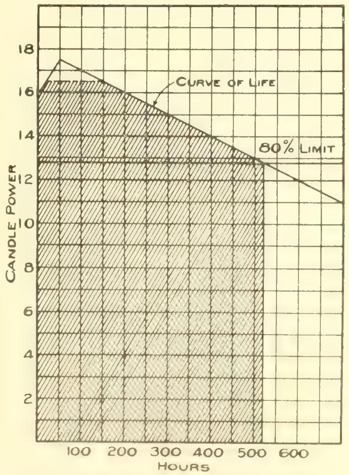


Fig. 8. Life Curve and Candle Hour Area.

[illegible] it, that point has been reached, according to present day incandescent lamp usage, when the candle power has declined to 80 per cent. of the original, or 12.8 c.p. for a 16 c.p. lamp. This is called the Useful Life, it is the only one of the two considered by modern lamp practice, and as such is called simply the life of the lamp. With good regulation a 16 c.p. 3.1 watt 100-125 volt lamp has a life of 400 to 425 hours, reducing the efficiency to 3.5 w.p.c. will double these figures, a 4 watt lamp will last four times as long.

The light emitted by an incandescent lamp grows constantly less and less for two distinct reasons; first because the filament burns away, thus increasing the resistance and consequently reducing the current, and secondly because the bulb gradually gets more and more coated by the deposit from the burning filament and thus passes less and less light. This fall in candle power is plainly shown by the curve of life in Fig. 8. The same cut also shows a shaded area which represents the product of the average candle power into hours of burning; this is known as the Candle Hour Area, and being a convenient method of expressing the performance of a lamp is frequently used in specifications. It is interesting to note from the curve that at first the candle power rises slightly, but as this is not a desirable feature, though not altogether avoidable, the lamp is not given credit, when calculating the candle hour area, for anything over 16.5 c.p.

Assuming equal efficiency a 32 c.p. should give just twice, and a 8 c.p. just half, the candle hour area of a 16 c.p. lamp. This, however, is not the case, as, if of the same efficiency, a 32 c.p. filament must have just twice the surface of a 16 c.p. Twice the surface means twice the amount of carbon dust coming off, and naturally to get the same darkening there must be twice the bulb surface to receive it. But a 32 c.p. has not got twice the bulb area of a 16 c.p.—it would be too costly and too unwieldly if it had—and so we find that relatively a 32 c.p. lamp darkens quicker than a 16, and thus gives somewhat less than twice the candle hour area. On the contrary, an 8 c.p. bulb has somewhat more than half the area of a 16, which means that on the average it gives rather more than half the candle hour area of that size. This relation between bulb and filament surfaces explains why lamps of the Meridian type do not exhibit any very marked darkening even if left until they burn out, from which it will be recognized that their life cannot be judged by the same standard as that applied to the regular bulb. It will further be evident from the same reasoning that 32 c.p. filaments in 16 c.p. bulbs must give very heavy blackening and thus short life.

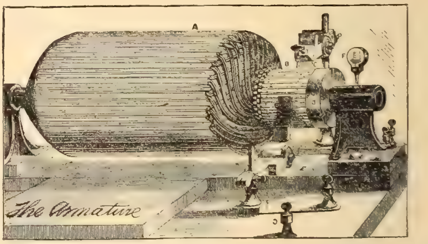
The life of an incandescent lamp is not affected by turning it on or off a number of times as opposed to continuous burning, nor by alternating as compared with direct current, nor, when burning on the former, by the frequency. It is affected by the candle power of the lamp, by the efficiency, and by the voltage, because these factors as they are changed one way or the other alter the diameter of the filament. As a small filament naturally has neither the electrical nor the mechanical strength of one of greater diameter, we find, as discussed under the heading of filaments, that high voltage, low candle power, and high efficiency lamps all tend to give shorter life than those of comparatively large candle power, low wattage, and medium voltage. The life is also very materially altered by the actual voltage at which you run; for instance, a voltage only 2 per cent. above that on which the lamp is supposed to be operated will lessen it by 30 to 35 per cent. The table shown in Fig. 9 covers this point in detail and should be carefully studied.

TROUBLE: This is naturally not a desirable thing to introduce, but as you will encounter it when dealing with incandescent lamps just as with everything else, it is well to be prepared. Practically the only form in which it will present itself to you is that of quick burn-outs and short life, lamps being brought in with the complaint that they burnt only a few hours, it is fortunate that from an inspection you can frequently tell pretty closely what is really the difficulty. First examine the filament, if the lamp did burn out the ends will be pointed and dull dead black in color, as opposed to the smooth steely grey of the balance. Failing these two evidences, the pointed end and the black color, but on the contrary finding the break square and grey to the end, you can positively assert that the lamp did not burn out, but was mechanically broken. On the other hand, presuming you discover evidence of burn-out, your next step in finding out why is to remember that the two most likely causes are bad vacuum and high voltage. A proper vacuum test involves the use of an induction coil, but you can get a rough idea of that in the suspect by comparing the vibration of its filament and that in a similar lamp known to be in good condition. If the vacuum be good the filament will vibrate more or less freely, depending upon the particular lamp involved, if the vacuum be bad the filament will be comparatively steady and come to rest almost immediately. Failing evidence of poor vacuum—and it must be borne in mind that this test is but rough and ready and therefore far from infallible—you would look at the color of the bulb, which is best viewed by holding it in front of a sheet of white paper. If this is appreciably darkened it means one of two things, either that the lamp gave normal life under normal voltage, or else abnormal life under abnormal voltage. You cannot get away from it, one or the other is correct, and your next course is to take a reliable voltmeter and go over the circuit. It is not sufficient that you get a statement from some one that the potential is O.K., but have it actually measured, the readings will frequently astonish you and disclose the definite source of the whole difficulty. High voltage is by far the most prolific source of lamp troubles, and consequently your potential should be rigorously kept within a small per cent. of normal, bearing in mind that it is not so much the potential at the power house which requires attention as that at the lamp itself; in other words frequent measurements all over the lines, both during light and heavy loads, and consequently a portable voltmeter, are absolute essentials to proper results from incandescent lamps. In this connection please refer again to Fig. 9 for a proper appreciation of the effect of high voltage on life. Occasionally you will find a burnt out lamp showing evidence of poor vacuum and having a star crack on the side of the bulb; this is due to static electricity having attracted the hot filament against the cold glass, this has cracked the latter at the point of contact, and air immediately rushing in has destroyed the vacuum. Static charges are due to various causes, but are usually most in evidence where there is considerable belting, especially in dusty situations, like cotton or planing mills. They are most frequently met in cold dry weather, under which circumstances the simple action of unwrapping the paper from a lamp is frequently sufficient to bring the filament hard against the glass. Lamps of large c.p. low voltage and low efficiency are not so liable to be affected by it as other classes because of their more rigid filaments. Moisture in the shape of water sprinkled on the floor, or a steam jet in the room, will usually remove all traces.

Volts		Candle Power		Watts per Can		Total Watts		Life
% Var from Normal		% of Normal	16 cp Lamp	% of Normal.	3.5 watt Lamp	% of Normal.	16cp 3.5w Lamp	% of Normal
Low Voltage	10	55	8.8	148	5.2	81	45.5	900
	9	58	9.3	142	5.0	83	46.5	710
	8	62	9.9	137	4.8	85	47.5	570
	7	66	10.6	131	4.6	87	48.5	450
	6	70	11.2	126	4.4	89	49.7	360
	5	75	11.9	121	4.2	90	50.6	290
	4	79	12.7	116	4.1	92	51.6	230
	3	84	13.4	112	3.91	94	52.7	190
	2	89	14.2	108	376	96	53.8	150
	1	94	15.1	104	3.63	98	54.8	125
Normal		100	16	100	3.5	100	56	100
High Voltage	1	106	17.0	96.5	3.4	102	57.3	81
	2	112	17.9	93	3.3	104	58.3	66
	3	118	18.9	90	3.2	107	59.7	55
	4	125	20.0	87	3.1	109	60.8	44
	5	132	21.1	84	2.94	111	62.0	36
	6	139	22.3	81	2,84	113	63.3	29
	7	147	23.6	78	2.75	116	647	25
	8	155	24.8	76	2.66	118	66.0	20
	9	164	26.2	74	2.58	120	67.4	17
	10	173	27.6	71	2.5	121	688	14

FIG. 9.—VARIATION OF CANDLE POWER WATTAGE AND LIFE WITH CHANGES IN VOLTAGE.

RENEWALS: There are as you know two distinct methods of renewing, that by which you charge your customers for the new lamps, which means renewing when burnt out, and the free renewal system, which means renewing when the lamps have reached the end of their useful life. The first means lamps bought here and there all over the country in an effort to get a cheap equipment, which means usually a poor one, it means lamps of low efficiency, thus if you are running a meter system (which by the way you should be if you are not) your bills are high and your customers are dissatisfied, if operating on a flat rate system your coal pile is suffering. In the one case your lamps are black and giving next to no light, consumers already on your books want to get off, and nobody else is anxious to take their places; in the other your light is always bright and attractive, and your accounts are cheerfully paid. Lose no time in introducing the free renewal system, it will pay you several times over, seizing such an opportunity as a proposed reduction in rates, or the introduction of meters, as a chance to make the change as a concession in



THE ARMATURE OF THE DYNAMO SUPPLYING THE LAMP SHOWN IN FIG. 1.

lieu of the one or a step in keeping with the progress indicated by the other. You own and manage the generators and the lines, and would not think of allowing each customer to handle them at will, why do so with the most important part of the system, that which everyone sees and by which they judge you, the lamp itself. You regularly clean and overhaul your engines and boilers so that they may be repaired and replaced before they break down and absolutely cannot run any longer, why not give at least a part of the same attention to the lamps, to which after all the engines and boilers are but as a means to an end. Why worry about 2 per cent. less efficiency in a transformer, and swallow without question a 10 to 12 per cent. increase in the consumption of the lamps themselves, why cheerfully trim an arc lamp every 100 hours, and yet consider it unreasonable that the incandescents should ask to be trimmed every 700 to 800, why have a meter department, and yet not one single man who is really responsible for the incandescent lamps on your circuit? As has been previously pointed out, the incandescent lamp is the main source of central station revenue and that part of the system which your customers see and use, the part by which they judge you; any defect or neglect in it is felt right back to the coal pile—is it not in order that more of the careful engineering and energetic management which is given to engines, generators, lines, and transformers should be given to that part of the system to which they are all tributary and without which they are just so much waste effort, the Incandescent Lamp.

THE ECONOMY OF ISOLATED PLANTS.

By K. L. Aitken.

The first question which presents itself when giving consideration to "isolated electric plants" is the exact meaning of the phrase. At first sight this would appear a very simple matter, but upon going into the question, complications present themselves which tend to confuse and make more difficult an interpretation of the words.

The "central station" according to the general understanding, consists of a power house which supplies energy in an electrical form to a comparatively large number of consumers, whose places of business are widely distributed. The isolated plant is primarily an equipment installed by an individual or company to supply his or its lighting and power circuits. There are, of course, central stations which are laid out on a small scale, and on the other hand, isolated plants exist which are very much larger than even central stations of average size. Such isolated plants may supply energy to a large number of buildings all of which are owned by and are units of one commercial enterprise. Under such conditions the equipment can still be classified under the term isolated plant; although the amount of power which it supplies and the area distributed over greatly exceed the energy and distribution of the central stations which can be found in our towns and even cities. Consider that a company has a large factory and has installed therein a complete generating equipment, and that near this factory there is a small concern requiring electrical energy. The larger factory agrees to furnish power to the smaller concern upon either a flat rate or meter basis. Then the question arises, does the large plant, by this action, lose its identity as an isolated equipment, and become a central station? If all the power generated by this plant be consumed within the building which contains the equipment, and one floor or room in this building is rented to some other person or concern than the owner of the building, and power and light is sold to this person or concern, does this action make the equipment a central station?

From the above it will be seen that it is a difficult matter to differentiate between the two classes of equipments—the place where the line should be drawn is not clearly defined. However, so far as this paper is concerned, I am going to deal with the smaller class of isolated plant which supplies power and light only to the building which contains the equipment, irrespective of the number of individual consumers in such building, and shall consider the economy of such plants in relation to the cost of buying light and power from a local central station. In other words, I shall assume the position of the purchaser of light and power who wishes to ascertain whether or not it would be a paying investment to install a plant of his own.

The information embodied in this paper is based upon reports which I have submitted covering the various phases in which the problem has been presented to me, both in the City of Toronto and in other localities.

People have often come to me and asked, in a very indignant tone, why they have to pay more per kilowatt hour for their lighting than for their motors, having been informed upon good authority that there is little or no difference between the kinds of electricity supplied for both purposes. For instance, they will be paying three cents for their power, and ten cents for their lighting. This brings forward a phase of the isolated plant question which is really of greater importance than size—I refer to load factor. This point I intend to take up later, and will therefore give it but little attention now. As an illustration, however, of the reason for this great difference, in prices of light and power, I wish to go over roughly the general condition of things which can be found in almost any central station. Let us presume that a power company has a constant ten hour load of one thousand horsepower, and, that to carry this load they have boilers, engines, and generators, with a capacity of exactly one thousand horse. Thus, the equipment will be running at full load throughout the entire day, and therefore at its point of highest efficiency. The load output for a ten hour day will be ten thousand horsepower-hours. Now let us consider the lighting question: presume that this same company supplies to the power consumers a maximum of one thousand horsepower for lighting. This means that the equipment for supplying this energy must have a capacity of one thousand horsepower, but the experience has been that this load is carried on the average not more than two hundred hours per year. As this season will be in the fall, winter, and spring of the year, we can assume that this load is distributed over appeoximately one hundred and fifty days, or is carried on an average an hour and twenty minutes per diem. This means that the daily output of this thousand horsepower lighting plant is only thirteen hundred horsepower-hours. Summing the matter, we have two equipments, each of one thousand horsepower capacity, one supplying ten thousand horsepower-hours per day, and the other only thirteen hundred. Therefore, it is not difficult to understand from the foregoing why the energy for power will cost three cents, and the energy for lighting ten cents. If we assume that the above prices are per horsepower-hour for the sake of argument—they are really per kilowatt-hour—we find that the income per day for power is $300, and the income for light is $130, and this latter only for one hundred and fifty days per year. If we average this lighting figure for the whole year, we find that the daily income is in the neighborhood of $65, which certainly contrasts very unfavorably with the $300 daily income from the power equipment. While the interest, depreciation, and insurance—or constant items—will be the same for both plants, the coal, labor, water, oil, etc.,—or variable items—will be reduced, but not nearly in the proportion by which the output of the lighting generators is reduced. Upon going into the matter very fully we find that the relative figures of three cents and ten cents are very close to what they should be.

From time to time, I have had occasion to visit people who have isolated plants, and in reply to my inquiries have been informed that the operation of the plants is very satisfactory. Upon endeavoring to obtain further information concerning the actual cost of operation, I have been advised that the installation of the plant has made a very material saving over the cost of electrical energy as it was purchased from the local central station. These matters have always interested me, and in several instances I have gone into the propositions simply to get information for my own use, and I must say that the results have been surprising. One of my friends advised me that by installing his plant he had not actually decreased the cost of his lighting and power, nor had he increased the item, but that with his plant installed he was using about double the amount of energy, without additional cost. I went into this particular case very carefully, and ascertained that the statement pertaining to the doubled consumption was quite correct, but I found that the cost per kilowatt-hour for the plant was over eight cents whereas the price paid to the local power company had been six cents.

To be quite frank, I have found very few plants which fulfil my understanding of the word economical, and in every case, the owners of such plants had told me that the installation had proved a decided success. All this leads me to draw certain definite conclusions, namely, that where uneconomical plants have been installed, the owners know that a mistake has been made, and are not willing to admit it, or else they have no idea whatever of the many items which must be charged against the operation of a plant.

Boilers, engines, piping, condensers, generators, building, heating, etc., etc., are all important features in the economical operation of any equipment, and must not be lost sight of; but over and above all else stands the one item of load factor.

The best condition is to be found in a manufacturing establishment, having an all-day power load which is fairly steady, and a lighting load which is small in comparison with the power required. Of course, if the lighting could be eliminated entirely, the load would be an ideal one, but such a condition is seldom found. Were this the case, the average economy of isolated plants could be materially increased.

Where the amount of energy required by lights is large compared to that taken by motors, the plant must have a capacity sufficient to handle the combination of the two and therefore the load factor of the system will be low, and the daily output in kilowatt-hours will be very much less than the possible all-day full-load output. In contrast with that which I have designated as the best condition, we find the worst in hotels and apartment houses. Here the service must be for twenty-four hours, and for about eighteen hours of this period the load on the plant will not average more than five to ten per cent. of the rated capacity. It is this low load operation that is responsible for the poor economy of many of the plants installed to-day. One instance of this is to be found in a certain Toronto plant. Two generators of the same size, each direct connected to an engine, are being run twenty-four hours per day, one to supply lights, and the other a number of elevator and other types of motors. This plant has been very badly laid out, and therefore cannot be taken as a fair example, but I am incorporating some figures taken from it as an illustration of the inefficiency of low load operation. The lighting machine supplies about 1,925 kilowatt-hours per week, and the power machine about 385, or approximately 20 per cent. of the energy used for light. On actual test of this equipment, I found that the coal consumption of the power machine was about 60 per cent. of that of the lighting machine. I might say in connection with this plant that both machines are running very much under their rated loads, the average for the lighting machine being 29 per cent., and for the power machine only 5.8 per cent. The power machine carries a normal load of but a few horsepower, but when the two elevators, which it supplies, happen to start at the same instant, the kick runs up as high as twenty-five horsepower. With the lighting machine the general conditions are better. For eighteen hours, a load of about 7.5 kilowatts is carried, and for the remaining six hours from 30 to 40 kilowatts. This plant, as I mentioned previously, is badly designed, and besides has a very unsatisfactory load to handle. The combination of the two produces a result far from gratifying to the owners.

In contrast to the above, I wish to bring to your attention an equipment installed in a Toronto factory. There is one 50 kilowatt generator, and this handles both the lighting and power. The possible maximum for lighting amounts to about 15 kilowatts, and for the power we have a total of 80 horsepower of motors, which take from the generator about 15 kilowatts, and give an exceedingly steady load. The lighting load is really very small, the highest consumption yet recorded from this source not exceeding 7 kilowatts, and rarely going so high. Here we have a plant running ten hours per day under a load of but 30 to 40 per cent. of its normal capacity, and while the yearly output is less than one-half of that of the plant previously mentioned, the cost per thousand watt-hours is considerably lower. I ran this plant for almost eleven months, during which time the output was recorded by watt-meters, and a careful record was kept of all operating expenses. The total output during this period was about 37,000 kilowatt-hours, and the cost per thousand watt-hours was but a trifle over four cents. The generator is now considerably larger than is actually required, but the total equipment of machinery throughout the building has not yet been installed. When this plant is running up to its full capacity, I am confident that the total operating cost per kilowatt-hour will be lower than three cents.

The foregoing figures are taken from tests of plants in actual operation. In each of these two cases, I figured the operating cost on paper before making the test itself, just to see how close such estimates could be made, and the results were exceedingly satisfactory. The other figures which I am incorporating are estimates concerning plants now being installed, or which are still on paper. However, I am reasonably sure that they are of equal value to those obtained by actual test.

Some time ago, I had charge of a proposition where it was proposed to install a small plant. The size of the generator in this case was 30 kilowatts, but the load factor was so bad that although we have our boiler installed and also have in our employ a fairly well paid engineer, the estimated cost per kilowatt-hour was almost six cents. The proposition was therefore dropped. If sufficient additional power load could have been secured for this equipment (the load is all lighting with the exception of one small elevator motor) the operating cost could have been reduced to below three cents.

As all the foregoing applies to very small equipments, I wish to present figures concerning larger plants, to show that the feature of load factor applies in such cases also. There is a general notion that the large plant is inherently a good proposition, it being possible to employ higher grade men, use more efficient boilers, and possibly run compound condensing engines. While this is perfectly true, if taken generally, still it does not necessarily follow that the large plant will be a paying proposition. The cost of energy per kilowatt-hour will doubtless be less, but at the same time must be considered the fact that if this energy were purchased from the local central station, the large consumption would command a very favorable price.

The first figures which I am going to give pertain to a building which requires a twenty-four hour service, six days per week. For twelve hours on Sunday, the entire equipment is closed down. From ten o'clock at night until seven the following morning, the load runs slightly less than 50 kilowatts. From seven in the morning until the evening lighting comes on, the load amounts to 150 kilowatts, and when the lighting is added to this, the total is brought up to between 500 and 600 kilowatts. This total is on for a couple of hours, and gradually falls off until the 50 kilowatt point is reached about ten o'clock. For handling this load, three units are to be installed, one 50 kilowatt, one 200 kilowatt, and one 300 kilowatt. Each generator is direct connected, the small machine being operated by a simple high speed automatic engine, while the two other machines are operated by tandem compound high speed corliss valve engines. All three machines may be run either condensing or non-condensing, depending upon the season, and the amount of exhaust steam required for heating the building. The boiler equipment will probably consist of four 200 horsepower units, either of the internally fired or water tube type.

The load factor of the plant can hardly be termed as very good, but still the operating cost is not excessive. For a yearly output of approximately one million kilowatt-hours, the cost per thousand watt-hours will not exceed two cents, and may be a trifle lower than this.

I have one more plant upon which I wish to present figures, and its load is of a peculiar nature. For twelve hours per day, every day in the year, it carries a full load of four hundred kilowatts. There are two 200 kilowatt generators, each direct connected to a tandem compound high speed corliss valve condensing engine, and besides this there is a third unit of 200 kilowatts capacity as a spare. Two 300 horsepower water tube boilers, carrying a pressure of 150 pounds, will supply the two running units, and there will also be a third boiler of 300 horsepower as a spare. The engines will always run condensing.

I have taken up roughly the question of superheating the steam for this plant, but at the present time, am not prepared to make comment on this feature. However, it is doubtful if superheating be employed for any other purpose than to supply the engines with perfectly dry steam, and for this purpose a small percentage of superheat will be sufficient.

The annual output of this plant will be about a million and three-quarter kilowatt-hours, and the cost per thousand watt-hours approximately one and three-quarter cents. In spite of the very favorable load factor, the cost of operating is not as low as might be expected, when comparison is made with the figures given for the previously mentioned plant of large size; but in the former case, a large volume of exhaust steam is required for heating and this estimated heating expense is deducted from the gross operating cost of the plant, and also there are no spare units installed. In the latter case, it is of the utmost importance that continuity of service be maintained, and this has led to the installation of 50 per cent. reserve capacity. And besides, there is no heating whatever in connection with the equipment.

This heating question is a very interesting one, and it is quite possible that in the future steam distributing systems will be installed in our Canadian cities, on the same scale that the idea has been adopted in the States. While running condensing means a very material saving in plant operation cost, still the revenue which can be obtained from the sale of exhaust steam for heating purposes will really effect a much greater economy. In scattered districts this method of heating is not very desirable, but where the power house is in a congested district the question of going into the steam heating business is very worthy of consideration.

The installation of reserve units in isolated plants is a problem requiring much study and experience, for the greater the unused capacity of the plant, the lower will be the economy. In a recent installation outside the City of Toronto, the steady power load amounts to 20 kilowatts, and the lighting load to 30 kilowatts. To take care of this, two units have been installed, one a 25 kilowatt machine, and the other a 35 kilowatt. To carry the combined lighting and power loads, both machines will be required, but in the event of an accident to either unit, the majority of the motors can be kept in operation by either generator, and therefore such an accident will not mean a complete shutdown. This arrangement is one which will have fairly good efficiency, and will minimize the chances of a complete closing of the factory.

In an isolated plant, the cost of distributing is generally very much less than in the case of a central station, and therefore such a plant has one very favorable feature on its side, when considering the question of comparative prices. I might say at this point that the figures of costs which have been given in this paper are costs at the switchboard, and that no consideration has been given to distributing, it being assumed that the cost of distribution would be the same whether power were made or bought.

In summing the isolated plant question, I would say that many equipments have been installed which really have not deserved more than passing consideration, and on the other hand, there are many situations where a private plant would mean a material saving. Load factor is the item requiring greatest consideration, and it is safe to say that wherever this is in anyway favorable, the installation of a private plant will effect a material saving over the cost of purchasing energy from a steam driven central station.

I thank you, gentlemen, for your attention.

NOTES ON THE POLYPHASE INDUCTION MOTOR.

By H. A. Burson.

It is the purpose of this paper to briefly set forth the characteristics of the Polyphase induction motor, the various types and the classes of work to which each are suited.

The induction motor is essentially a transformer. At start it is a static transformer, and when running, is a transformer with the line frequency in the primary, and a frequency equal to the slip in the secondary. The static transformer is designed with as little leakage as possible. This is accomplished by properly winding and grouping the coils, and making a good magnetic circuit. The magnetizing current is small and the power factor high even at light loads. In the induction motor, on the other hand, the leakage is comparatively large. The primary winding is on the stator core and the secondary winding on the rotor core. Between these cores is an air gap which increases the leakage and the magnetizing current ; and the power factor at no load is practically zero.

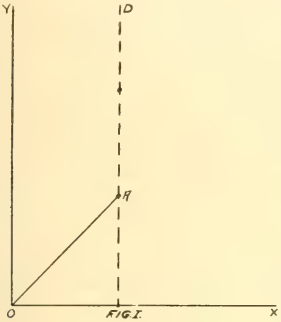


FIG. I.

The vector diagram of a static transformer without leakage is as shown in figure I. If OA represent the no load current vector, angle AOY being the angle of lag, as the non-inductive load increases, the power factor of the primary will increase, and the locus of the point A will be the line BD parallel to OY. In the induction motor, however, owing to the leakage, the locus of the end of the current vector is not a straight line but a circle as shown in figure II. OA is the no load current, OA^1 is its wattless component and AA^1 is watt component. As the load increases on the motor the end of the current vector moves along the circle ABK, centre G. It will be seen at a glance that the power factor does not continue to increase with the load, as in the case of the static transformer without leakage, but reaches a maximum at the point C and then begins to decrease It will also be seen that if the value of OA be decreased for the same diameter of circle, or the diameter of circle be increased for the same value of OA, the maximum power factor will be increased The value OA/OK is known as the leakage factor, and to keep it as low as possible is the aim of the designer.

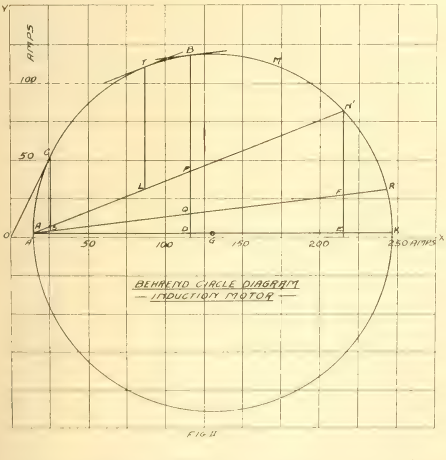


FIG II

This leakage factor depends upon the design of the machine. Mr. Behrend in his excellent book on the induction motor, states that it varies directly as the air gap, and inversely as the pole pitch. He gives the formula $\sigma = C\frac{\triangle}{T}$ where σ = leakage factor, T = pole pitch, $\triangle$ = air gap, and C = a constant depending upon the type of machine. Much has been written of the value of this constant C, and several tables have been compiled. The writer considers that for a certain type of a machine, its value depends upon the pole pitch and the width of core, and has found that the formula to give most consistent results is $C = \frac{K}{\sqrt[3]{TB}}$. Where B = width of core, T = pole pitch, and K = constant.

Nothing has as yet been said of the motor losses. These are the iron and copper losses. The former is approximatly constant, and is taken into account by the energy component of the no load current AA^1. The copper losses, on the other hand, vary as they square the current load and it may be proved that the ordinates between the lines AK and AR represent the stator C^2R loss, and between AR and AN the rotor C^2R loss.

It is now a simple matter to determine the characteristics of the motor. Take for example the point B. The current per phase is OB. Its energy component is BD, and hence the power factor is BD/OB. The total losses are represented by PD, the total input by BD, and hence the output is BP, and the efficiency is BP/BD. The slip, as may be proved, is equal to rotor C^2R loss divided by the total input into the rotor, and is therefore PQ/BQ. These quantities may be found for several points and complete performance curves plotted as shown in figure III.

The point N is the position of 100 p. c. slip, and hence ON is the starting current per phase at normal voltage, and NF the starting torque. It will be seen that if the rotor resistance be increased to raise the line AN to the position AN^1, the starting current is reduced and the starting torque increased. The maximum starting torque is when the line AN takes the position AB. Increasing the rotor resistance however increases the rotor C^2R, and hence increases the slip and decreases the efficiency at full load. Hence the starting torque allowable at normal voltage depends upon what conditions must be met as regards efficiency and slip.

The maximum overload which the motor will stand before falling out of step is represented by TL. To increase this value for a given machine the rotor resistance may be decreased or the diameter of the circle increased. The former means a decrease in starting torque and the latter an increase in the no load current and a decrease in the full load power factor. As Mr. Behrend remarks "A design is more or less of a compromise, and the best design is that which combines the greatest number of advantages with the least number of drawbacks."

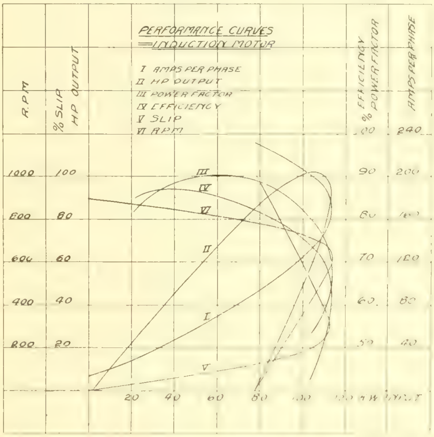


FIG III.

Again referring to figure II it will be seen that the starting current at normal voltage may be from four to six times full load current. In a motor with constant rotor resistance, that is a squirrel cage motor, this value may be cut down by the use of an autotransformer to reduce the applied voltage at starting. The effect of this on the circle diagram is to reduce the magnetizing current and circle diameter approximately as the reduction in the applied primary voltage. The starting current will be reduced proportionately as the voltage, but the starting torque as the square of the voltage. If a small starting torque is required, such as when the motor starts light, the starting current from the line may be reduced to full load current. If on the other hand a large starting torque is necessary, as when motor starts under load, it is impossible to reduce the starting current materially.

To meet the conditions of a high starting torque and a low starting current, a motor with coil wound rotor and variable external resistance in the secondary is used. The circle diagram for such a motor does not change with the exception of the position of the line AX. At start sufficient resistance is introduced to cut the primary amperes to a value, for example, OC. The starting torque is represented by CS. As the motor speeds up resistance is cut out, and when maximum speed is reached the rotor windings are short circuited. It will be seen that with such a motor it is possible to combine high starting torque, low starting current and high efficiency under load.

The question of squirrel cage motors versus external resistance motors is much discussed. In Europe the latter are largely used, while in this country the former are in preponderance. The advantages claimed for the squirrel cage type are, simplicity of operation, small cost of repairs, and cheaper first cost. The disadvantages are large starting current under load, and large slip if high starting torque is required. Small motors which will not be required to start under too heavy load, should be of the squirrel cage type, while for those of larger capacity the external resistance type is preferable. It is a question for the purchaser to decide, taking into his starting conditions and power contract.

In this connection the writer would like to draw the attention of Engineers to the issuing of induction motor specifications. It must be remembered that power factor, efficiency, slip, starting torque and overload capacity are, to a certain extent, interdependent. For example, to specify that a motor shall have a slip at full load not to exceed 3 p. c. and a starting current not to exceed twice full load current, the motor to be started under load, is, as has been shown, to say the least, inconsistent.

SUGGESTIONS FOR STEAM ECONOMY.

By Wm. McKay.

Almost every engineer and electrician is familiar with the fact that the majority of steam-power plants are not operating under the most economical conditions. In some cases this is due to the plant having been built up piecemeal as the requirements developed and in other cases it has been found difficult to determine the amount of power that would actually be required until after the plant was completed. If the consulting engineer could be informed, or could determine in advance the exact requirements for the present and future, it would be comparatively a simple matter to design the plant with fair accuracy as to the size and number of units, types of engines, boilers, and other details.

Although it is difficult to give any general information on this subject which will be of use or interest in the great variety of particular cases in which the members of this association are interested, it may be of some interest, and possibly of assistance to those who are managing or operating power plants, to discuss some of the principles upon which economy in the use of steam depends.

Beginning with the boiler, which is the first step in the production of power from fuel, it may be laid down as a good rule that it is more economical to use boilers of reasonably large size than to subdivide into a larger number of small units. The length and area of grate that can be conveniently fired or kept evenly covered with coal is, perhaps the limiting feature, if hand firing is to be used. Working from this rule, a grate should not be over seven feet long or more than five feet wide, which would give 35 square feet of grate surface. The quantity of coal that may be burned on such a grate varies widely with the kind of fuel and strength of draft. Using bituminous slack coal of fair quality, with good natural draft or moderate-induced draft, it should be possible to burn 25 lbs. of coal per square foot of grate per hour, or 875 lbs. of coal per hour, and if this coal will evaporate say 8 lbs. of water per pound of coal, the boiler, if constructed with heating surface in proper proportion, would evaporate 7,000 lbs. of water per hour, which would be equal to a little over 200 standard boiler horse-power. In order to give good economy, the boiler should have from 2,000 to 2,400 square feet of heating surface to evaporate this quantity of steam economically. The return tubular boiler, on account of the amount of tube surface in proportion to the direct surface exposed to the fire, should have not less than 12 square feet per horse-power; the water tube type from 10 to 11, and the internally fired type, which has a larger amount of direct heating surface in the furnace and tubes than either of the others, should have 9 to 10. If the grate surface is larger than that described, probably the grate will not be evenly covered with coal, or the fire will be dead in spots, so that too much cold air will pass through.

The economy in burning fuel is a matter requiring great skill and experience, and depends entirely upon the evenness, thickness and condition of the fire, which controls entirely the air supply and, therefore, the perfection or imperfection of the combustion, and I would say just here that there is very little use in "spliting hairs" over a quarter of a pound of steam consumption of the engine, while the fireman may be losing ten times this quantity of fuel from inefficient boilers or poor firing.

I fear it is too often the case that the demand for increased horse-power are met by grate surface too large in proportion to the heating surface of the boiler or forced draft, and too little attention is given to careful firing, with heating and grate surfaces in proper proportion to give best economy, and frequently a great deal of money is spent in obtaining high-class engines and condensers, whereas the principal loss is in the boiler and fire room.

The question is often asked whether in case of installing a certain horse-power of boilers, say 300 horse-power, it would be more economical to have three boilers of 100 h.p. each or two boilers of 150 h.p. each. I would say by all means have the two larger units, as it will always be found that the larger boilers have less radiation, less air leakage and better combustion than a corresponding horse-power in small units. If it is necessary to have a spare unit for cleaning, let there be another one provided of the same size.

In regard to the pressure to be carried: It is well known that a high pressure gives a greater amount of expansion and better economy in proportion to the fuel burned. Even with simple engines in which it is not possible to obtain the full advantage of expansion, the high pressure of steam, which is drier and contains a larger number of heat units in proportion to the volume, gives the best results. I think every boiler should be designed for not less than 150 lbs. pressure per square inch. Even if it is not possible to utilize the full pressure, the boiler will be stronger, last longer and a better investment in the long run. In this respect, the water tube or some form of internally-fired boiler in which the shell plates are not exposed to the high temperature of the furnace, are certainly safer than the horizontal return tubular boiler, because for large units intended to carry high pressure, the shell plates and seams must be of considerable thickness, and being directly exposed to the hottest part of the fire, are almost sure to give trouble, especially if there be any scale or sediment in the water which is liable to settle on the bottom directly over the fire.

As to the economy of various types of boilers, experience shows that any of the standard types, horizontal return tubular, water tube, or internally fired, if they are designed with proper proportions of heating and grate surface, give about the same evaporation per pound of coal, provided they are in good condition and clean both on the fire and water surfaces. While the externally-fired boilers, either of the return tubular or water tube type, are said to have some advantage in combustion, on account of the heat of the brick furnace, they are subject to losses which are more serious, in the way of air leakage and radiation. Tests made at the Ohio State University, by Professor Hitchcock, show that the brick-setting of boilers continues to absorb heat up to 72 hours after being started, and that the average waste of heat in brick furnaces is about 8½ per cent. As the members of this association well know, the repairs and cost of keeping up brick furnaces is considerable, and as a result of deterioration there is more or less air leakage through the brickwork going on constantly. In this respect, the internally-fired boiler has a great advantage over return-tubular or water-tube boilers with brick furnaces, as it will be just as efficient after continued use as when first started.

In any type of boiler it is of great importance to keep the tubes and other surfaces free of soot and scale. Otherwise, a large loss may be sustained. I think it is a mistake to depend entirely on the steam blower or tube cleaner, which only removes the loose soot, a scraper being necessary for occasional use to free the hard scale, which will in time accumulate on the fire surfaces. It is necessary to point out that scale, or worse still, oil on the inside of a boiler may be a source of great loss, experience having proved that even a thin film of oil will so prevent the transfer of heat that the plates or tubes will be burned in a very short time. Nothing but pure water should be used for making steam, and the practice of making the boiler do duty as a water purifier as well as a steam generator cannot be too strongly condemned. If the owners of steam plants could be made to realize that a very small deposit of soot on the outside and scale on the inside means a loss of from 10 to 20 per cent. of the total fuel consumption, costing, perhaps, thousands of dollars per year, they would be convinced that it would be much cheaper to spend money in purifying apparatus, so that the scale or sediment will be removed before the water is fed to the boiler.

The next step to be considered is the heating of the feed water. This may be accomplished in two or three ways: First, by means of the exhaust steam, which, coming from a non-condensing engine, is capable of heating the feed water to 212 degrees and of saving say 12 to 15 per cent. as compared with feeding cold water. For large plants where it would pay to use induced draft to make up for the loss in temperature of the chimney gases, which produce the draft, it will undoubtedly pay to use an enonomizer, but as this apparatus is expensive both in first cost and up-keep, the amount saved in utilizing the waste gases from a small plant would probably not offset the outlay. The closed type of feed-water heater is about as efficient as the open type, provided the water is pure and it avoids trouble from pumping hot water, but the open type is frequently made use of to assist in purifying the water and, if properly managed, may give good service in that respect. For condensing engines, a primary heater of the closed type may be installed between the engine and condenser, which will help to condense the steam and heat the feed water to a low temperature, say 130 to 140 degrees Far. A secondary heater, either of the closed or open type, may be used to heat the feed water to a still higher temperature, say 212 degrees, by the use of the exhaust from the feed and air pumps, which cannot be used more profitably than in this way, as all the heat is returned to the qoiler.

In regard to the type of engine used for the plant: If the size of plant is sufficient, and the work comparatively steady, the highest possible results may be obtained from compound condensing engines using the highest possible pressure of steam, but under other conditions, such as variable load, low pressure of steam, it may be quite possible that the simple engine will give better results and cost less for repairs. With low-steam pressure, non-condensing, there is certainly nothing better or more economical than a single-cylinder Corliss engine where it can be installed to advantage. In the case of direct-driven electric units of small size, it is necessary to use high or medium-speed engines, both on account of the loss in friction that would come in if countershaft and belting have to be used and because the higher speed machines will give the best regulation. For small units up to say 75 or even 100 horse-power, there is nothing better than the modern high-speed, automatic engine, provided it is of good design, not overloaded and not overspeeded. A well-designed engine with 12-inch cylinder and 12-inch stroke, which is usually run at 275 to 300 revolutions per minute, and made to develop from 75 to 80 horse-power, if arranged to run at say 225 to 250 revolutions per minute and to carry 50 or 60 horse-power, will be as serviceable and give as good results as any type of engine of the same horse-power under ordinary conditions non-condensing, and if the work is variable, requiring quick, close regulation, such as driving electric generators, where the load is irregular, say for supplying current to electric lights and electric elevators, the short-stroke, single-valve type of engine has great advantages.

As illustrating the small wear of high-speed engines under favorable conditions, a Robb-Armstrong engine of 12-inch stroke, which has been running at 275 revolutions per minute for electric lighting for twelve or fourteen years, shows only about two-thousandths of an inch wear of the journals, and six-thousandths of an inch wear in the shaft bearings.

Unfortunately, this class of engine is so frequently overloaded and overspeeded that it gives poor results and gets a bad name, whereas the Corliss slow-speed type of engine is limited both in the matter of speed and horse-power, because the cut off of the single-eccentric type will not go much beyond half stroke, and in that way the engine is saved from overloading and buse, and this is, perhaps, one of its many advantages. A compound engine is not suited to low pressure or irregular loads and the extra cylinder and complication of parts is a great objection under such conditions. When a condenser is used, even with low pressure and somewhat irregular loads, it may be employed to advantage and with high pressure, say from 125 to 150 lbs. or over, the non-condensing compound will give the best results, unless the load is very irregular and running to light loads a large part of the time.

The question is sometimes asked whether it pays to reduce the pressure when the load is light. From my experience, I do not believe it pays to reduce the pressure on the boiler, excepting in very extreme cases, but if it can be done by throttling before the steam reached the cylinder of the engine, it would be an advantage, because this retains the heat units due to the higher pressure in the steam and the throttling has a slight super-heating effect. As a matter of fact, tests made by Willins & Robinson, of England, go to show that for light loads and high pressure, a throttling engine may do even better than automatic cut off. The ideal arrangement is to throttle the steam for light loads up to say near quarter cut off, and after that, for heavier loads, allow the variable cut off to come into play. This practice has been carried into effect by the design of Mr. E. J. Armstrong, in which he arranges the shaft governor so that there is negative lead up to nearly one-quarter cut off, after which the lead becomes positive, and this has the effect of throttling the steam for the earlier loads and undoubtedly gives better economy, in addition to making the engine run more quietly.

Another source of considerable loss in the operation of steam plants, particularly large ones, is the insufficient size of piping, causing the pressure to be reduced between the boiler and engine, and imperfect drainage, which is an enemy both to economy and the life of the engine. In many of the newer plants, it has been found a great advantage to install large receivers to equalize the pressure and to collect the water before it reaches the engine.

In general, it may be said that the principal causes for loss in steam plants is the use of engines which are overloaded or unsuited to the conditions of work, undersized, or badly-arranged steam and exhaust pipes, and the imperfect condition and poor operation of the boilers. In many plants, exhaust steam, which might be utilized for heating, is wasted, and in others, where the exhaust steam is utilized for heating, power is wasted by excessive back pressure. The most economical use that exhaust steam can be put to is for heating, because all the heat units are made use of, but it should be done without back pressure on the engine, by means of a vacuum system to draw the steam and water through the heating pipes, otherwise there will be a loss both of fuel and power, due to the engine working under imperfect conditions.

THE SELECTION AND MAINTENANCE OF SERVICE METERS.

The legitimate revenue of a company supplying electrical energy which is measured and charged for by meter, is determined only when such meters are intelligently selected and properly maintained.

Service meters must be selected with due regard to their mechanical construction, electrical characteristics and the installation to be metered; else their accuracy cannot be maintained and their operations will be short-lived.

MECHANICAL CONSTRUCTION.

A close inspection and, where possible, a test should be made of all parts which might affect the continuous operation of life accuracy of the meter. The inspection will include the form and number of terminals; the insulation between the terminals and to ground; dust-proof features; weight of the moving element; bearings; style of dial; adjustments, mechanical and electrical.

The form of terminal should permit ease of installation insure good electrical contact and make it difficult to tamper with the registration of the meter. The terminal proper should be protected by an insulating bushing, or so arranged that it would be impossible for the lead wire to come in contact with the case of the meter. When protected from the case by an insulated bushing the surface insulation is not only ample for the limiting line voltage of this class of apparatus, but also provides good ground insulation. Both sides of the line should be carried through the meter with both of the shunt leads taken off inside the meter, thus protecting it from persons desiring to tamper with its operation.

The current and voltage coils should be well insulated from the iron of the electro-magnet, so as not to break down under lightning discharge. These coils should be form wound, permitting cheap and ready repairs and minimizing stock of spare parts.

Dust is the chief enemy of an accurate meter, as will be demonstrated by a thorough cleansing of the bearings and moving parts of any meter that has been in operation for a considerable time. Many makes of meters have plenty of evidence of being dust-proof, but on close examination one may see that they are such in name only, and that the meter would have to be sealed in a glass case to be at all dust-proof.

The elements which vitiate the permanence of calibration of a meter in service are ageing of the permanent magnets, variation due to changing conditions of load, voltage, frequency, temperature, wave form, etc., and friction of whatever cause. The first of these elements is possible in isolated cases with any make of meter, but is practically absent in all makes of meters using permanent magnets whose magnetic circuit is one continuous piece of steel with a very narrow air gap. The second will be discussed under electrical characteristics. The third is due almost exclusively to the wear of the jewel bearing, and features should be incorporated into the design of the moving element and jewel bearing which will minimize the chances of a meter developing excessive friction.

The bearing after all is the strategic point of a service meter, and upon it and the elements affecting its life should be centered the best efforts of the designer. A construction which will make the friction a constant value permits the introduction of a compensating torque which will just overcome this constant friction.

The bearing should be so designed that the bearing point or pivot should not be continuously at one point but be free to move at a speed which is different from that of the moving element, this different speed continuously presenting new bearing surfaces between the jewel and bearing point or pivot. This condition is best met by a feature of the design shown in Fig. 1, which consists of a steel ball between two cupped sapphire jewels, one of which rotates with the shaft, and the other is mounted stationary in the jewel screw. A bearing of this type not only decreases the initial friction but by reducing the relative speed of the bearing point (the steel ball) and the jewel the life of the meter is multiplied several times, and consequently the life accuracy of the meter is increased in the same proportion. A further increase of life is obtained by the ball rotating in an orbital path instead of on a single point. The wear on the jewel is distributed over considerable of its surface and thus reduced to a minimum. The ball being free to move in any direction wears uniformly over its entire surface and is always in good operating condition, and has scarcely any tendency whatever to increase the friction of the bearing. The top bearing shown in Fig. 1 has proven very effective in reducing friction and preventing noise.

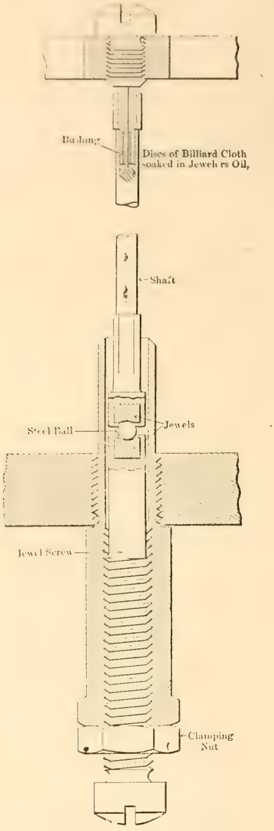


FIG. 1.

The dial should be plain and easily read, having no unnecessary markings upon its face. To minimize mistakes in reading the value of one division of the lowest reading counter should not be less than one kilowatt for any capacity of meter.

FIG. 2.

ELECTRICAL CHARACTERISTICS.

A thorough test should be made of the load and voltage curve of the meter, and where possible, a frequency curve should be taken. All three of these curves must be known to predict with any accuracy the performance of the meter under any other conditions of voltage and frequency than normal.

A type of meter should not be accepted which will not give a load curve of an initial accuracy of plus or minus 2 p. c. from 2 p. c. of full load to 50 p. c. overload, and maintain this accuracy in service for a considerable period when operated under normal conditions. Neither should a meter be approved which will not be accurate within plus or minus 2 p. c. from 50 p. c. of normal voltage to 25 p. c. overvoltage, and should have no tendency to creep under these conditions. Most makes of modern meters will have an error of less than 2 p. c. for a 10 p. c. change from normal frequency.

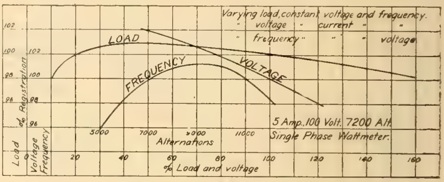


FIG. 3.

Characteristics of a meter with an unsatisfactory load and voltage curve.

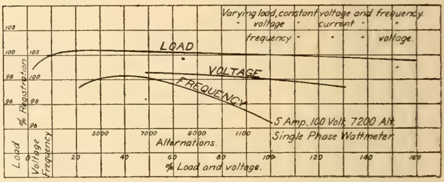


FIG. 4.

Characteristics of a meter with a satisfactory load, voltage and frequency.

The torque or driving force of the meter should be as large as it is possible to obtain with a minimum weight of moving element. To make the effect of friction as slight as possible the ratio of the torque necessary to overcome friction and the driving torque should be a maximum. This ratio may be increased by reducing initial friction and eliminating the causes tending to its constant increase; or it may be increased by an efficient design of the electro-magnet. Any attempt to increase this ratio by increasing the weight of the moving element above the minimum for mechanical strength is a gain only at the sacrifice of a considerable portion of the life of the meter.

The loss in the shunt and series coils should be small and the meter should be accurate on both inductive and non-inductive loads.

When it is desired to measure the energy of a circuit by a meter connected into the circuit through the medium of either or both series or shunt transformers, these transformers should be especially designed for use with meters.

Where there is to be a charge made according to the readings of such a meter the writer would recommend that this meter have its own individual series transformer.

CAPACITY.

When an installation is to be metered, a meter should be selected for the average load so as to utilize the inherent overload capacity of the integrating wattmeter. This is a feature usually taken into consideration for house service meters, and frequently neglected for switchboard service meters in the attempt to select a meter large enough to take care of the future growth of the station. The writer has in mind a modern switchboard installation in which the engineer insisted on such a large capacity meter that when several years later the attendants attempted to take hourly readings on the meter under full station load, they frequently got a smaller reading the last hour than the reading for the preceding hour. For switchboard service the meter should have a dial similar to that shown in Fig. 4, which will permit accurate hourly readings.

MAINTENANCE OF METERS.

Service meters have an inherent tendency to run slow after considerable use, and consequently should have a periodic inspection and test, the frequency of which will depend upon the types of meters used and the class of service.

This periodic test to be of any value can of course only be made while the meter is in service, and should be sufficiently accurate to indicate whether or not the meter should be continued in service or removed for recalibration. Several methods are used for this periodic test, such as an adjustable load of standard lamps and a voltmeter, or what is more convenient, and, when used with discretion, more accurate and reliable, a special standard integrating wattmeter. When using the latter method, it is only necessary to compare the speeds of the two meter discs to determine the accuracy of the meter under test. The special standard integrating wattmeter is usually provided with several current windings and at least two voltage windings so as to cover the range of the several capacities of service meters in use by the Central Station.

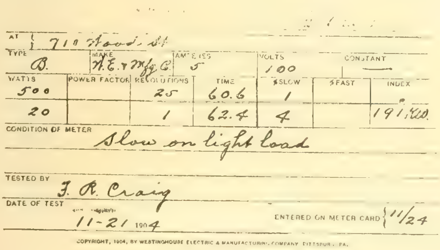
This meter should never be used as a primary standard, but as a secondary standard, and then only as such when the Central Station has a reliable and accurate standard for frequently checking its calibration

When the special standard integrating meter is of the same type as the meter under test, they will be subject to the same variations with changes of load, voltage, frequency, temperature, etc., and the relative speeds of the discs of the standard and the meter being tested will indicate directly the accuracy of the service meter. When, however, the standard and the service meter are of different types, the performance of both the standard and the type of service meter under varying load, voltage, frequency, temperature, etc., must be known, and allowance made for their difference before the standard meter will accurately indicate the condition of the meter being tested.

A reference to Fig. 3 will show how conditions may arise such that a meter will be in error several per cent. With an increase of 10 p.c. in frequency, at a 40 p.c. load and 90 p.c. voltage, the meter would be nearly 3 p.c. fast. If this meter was being tested by a standard integrating meter with characteristics same as shown in Fig. 4, it would be 3 p. c. fast. However, if tested by a standard meter with the same characteristics as shown in Fig. 3, it would indicate the same as the standard meter while it is actually 3 p. c. fast.

The primary standard is the "keystone" of the entire meter system. An operating company equipped with a good reliable and accurate standard and several of the integrating test meters can maintain cheaply and accurately a large number of service meters and increase its revenue by a considerable percentage.

The primary standard used in the calibration of other instruments should be of high accuracy in order to reduce the effect of any accumulative error. As they are not moved about to any great extent, they can be made of a size to obtain large controlling force. The type which depends upon the mutual attraction between two sets of coils is the form most suitable for a standard instrument, since in this form the minimum of disturbing influences enter. This type may be used on either direct or alternating current, is independent of frequency, wave form and power factor. A type of instrument of this kind which has recently been put on the market includes in its line a meter designed especially for testing integrating wattmeters, and it has a range equal to any three standard meters obtainable for this class of service. This meter has a range of accurate readings from 10 to 10,000 watts at 100 volts, and proportionate range at other voltages.



AT 710 Hood St.

TYPE	MAKE	AMPERES		VOLTS	CONSTANT	
B.	W.E.& Mfg. Co.	5		100	—	
WATTS	**POWER FACTOR**	**REVOLUTIONS**	**TIME**	**% SLOW**	**% FAST**	**INDEX**
500		25	60.6	1		
20		1	62.4	4		191 KW.

CONDITION OF METER Slow on light load

TESTED BY F. R. Craig

DATE OF TEST 11-21 1904

ENTERED ON METER CARD 11/24

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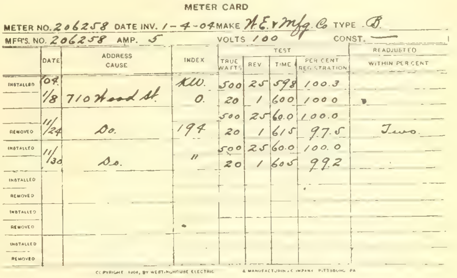
FIG. 5.

No maintenance bureau is complete without a convenient system of recording both the line and laboratory tests of the service meter. The sample cards illustrated herewith are especially adapted for this use and are evolved from many years' effort on the part of the Central Station manager to obtain a comprehensive and convenient system of records.

The smaller card shown in Fig. 5 is used in the field for noting the condition of meters as examined when in service. From these reports the meter expert decides as to the advisablilty of continuing the different instruments in service or of having them replaced and brought in for readjustment.. These cards are made of the standard size for a 3 x 5 inch card index. For convenience in use, they are mounted on stubs and fastened together in books.

The larger card contains the record of changes in service and adjustment, and gives a complete history of the meters, including date of receipt, time of installation, length of service and electrical performance. It has space for six entries, which will cover a period of from three to six years, varying with the frequency with which changes are made in adjustment and installation. The size is 4 x 6 inches, and each card is provided with a round hole for the retaining rod in a card index file.



METER CARD

METER NO. 206258 DATE INV. 1-4-04 MAKE W.E.& Mfg. Co. TYPE B.

MFR'S. NO. 206258 AMP. 5 VOLTS 100 CONST. —

	DATE	ADDRESS CAUSE	INDEX	TEST				READJUSTED
				TRUE WATTS	REV	TIME	PER CENT REGISTRATION	WITHIN PER CENT
INSTALLED	04		KW.	500	25	598	100.3	
	1/8	710 Hood St.	0.	20	1	600	1000	
				500	25	60.0	100.0	
REMOVED	11/24	Do.	194	20	1	615	97.5	Two
INSTALLED	11/30			500	25	60.0	100.0	
		Do.	"	20	1	605	99.2	
INSTALLED								
REMOVED								
INSTALLED								
REMOVED								
INSTALLED								
REMOVED								

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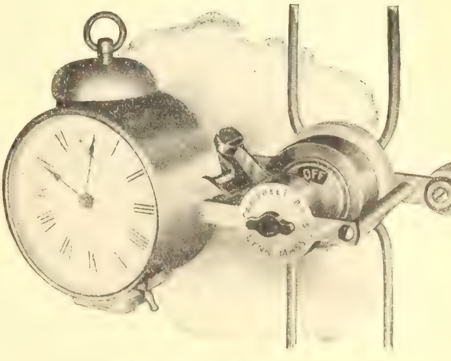
FIG. 6.

There are many points in the design of service meters of prime importance (to the operating company) which have not been discussed, but an effort will be made to focus attention on the most important features, not a few of which, in the writer's opinion, are entirely overlooked in the selection and maintenance of service meters.

—WM. BRADSHAW.

THE CAMPBELL TIME SWITCH.

The Campbell Time Switch, as illustrated herewith, is a new departure in the line of shutting lights off and on automatically. It is neat in design and can be placed anywhere the wires happen to run ; no shelf to build, no closet necessary, can be installed in five minutes, is artistically finished, well made and reliable. The clock can be detached in a second, and repaired as quickly. These switches are made from 10 to 35 ampere, double pole or triple. Style "A" turns light on or off. Style "B" turns light on and off. The prices are very moderate. The Sayer Electric Company, of Montreal, are agents for the Dominion of Canada.



THE CAMPBELL TIME SWITCH.

The "FIRE FLY"
THE MOTORLESS FLASHER

SAYER ELECTRIC
MONTREAL

THE NEW PRESIDENT.

The president-elect of the Canadian Electrical Association, Mr. Aaron Abel Wright, M.P. for South Renfrew, was born at Athens, Leeds County, Ontario, June 6th, 1840. He is a son of Israel Wright, who also was born in Ontario. A. A. Wright was educated at Athens High School, Toronto Normal School, Montreal Normal School and at a private school in Quebec. He married Miss Jane Harvey, of Lachine, Que.

Mr. Wright is president and managing-director of The Renfrew Electric Company, Limited, of Renfrew, Ont., and has always taken an active interest in the Canadian Electrical Association. He was elected to the House of Commons at the general election in 1900 and again at the general election in 1904. In politics he is a liberal. He has been a trustee of the Renfrew High and Public schools for 33 years.

Mr. A. A. Wright,
President-Elect Canadian Electrical Association

COQUITLAM—THE LONGEST POWER TUNNEL IN THE WORLD.

"Gentlemen, I will let the waters speak for me". These were the words of Sir Henri Joly de Lotbiniere, Lieutenant Governor of British Columbia, as on June 10th he turned the golden key that opened the longest power tunnel in the world.

The steamer Britannia was charted by Manager Buntzen to carry the guests of the Vancouver Power Company and the British Columbia Electric Railway Company to the north arm of the Burrard Inlet. The power house was reached in exactly one hour and twenty-five minutes. Highfield orchestra had been retained for the occasion and enlivened the trip by music.

Arriving at the power house the party were taken in hand by Mr. Buntzen, Mr. Sperling and other officials of the company. Two of the three immense generators were in operation. Reaching the entrance of the tunnel, everything there was resplendent with flags and other symbols of rejoicing.

A platform had been erected over the short canal leading from the portal of the tunnel and on this a stand had been erected. The platform and the walk leading to it had been carpeted and the whole presented a very pretty effect. Here Sir Henri Joly, Mr. Buntzen, Premier McBride, Hon. F. Carter-Cotton, Mayor Buscombe and others took their places.

A golden key had been made for the occasion. On one side were the words "Presented by J. Buntzen, General Manager B.C. Electric Railway Company and Vancouver Power Company", and on the other side, "Opened June 10, 1905, by Sir Henri Gustave Joly de Lotbiniere, K.C.M.G., Lieutenant-Governor". An engraving of the power house also appeared on the key, as well as the length of the tunnel, 12,774 feet.

The opening ceremony began with a few words from Managing-Director Buntzen, who briefly announced that Sir Henri would turn the key, thereby starting a motor at the upper end of the tunnel, which, opening the gates, permits the water of Lake Coquitlan to flow into the Lake Beautiful or Trout Lake as it appears on the maps. His Honor, at exactly 1 p. m., placed the key in the marble slab on the little stand and gave it a turn, letting loose the sleeping waters of Lake Coquitlam and supplying almost unlimited power to the cities of Vancouver and New Westminster and surrounding districts. Just 35 minutes later the flood poured through, carrying on its bosom a gay float bearing greetings from Lake Coquitlam. This completed the ceremony and all adjourned to the large tent where the banquet was spread.

Elaborate preparations had been made, great taste was displayed in the decorations and garnishments of the festal board, and the two hundred guests found their allotted places at the three long tables without the slightest confusion. At the cross table at the head of the long table sat Mr. Frank S. Barnard, who acted as chairman. On his right sat His Honor, while to the left sat Premier McBride, Mayor Keary, of New Westminster, and Mayor Barnard of Victoria. To the right of His Honor sat Mr. Buntzen, Sir Charles Hibbert Tupper, Mayor Buscombe and others. The luncheon, like everything else in connection with the day's outing, was a credit to the company.

The toast list was opened by "The King", which was duly honored, all rising to their feet and joining in the National Anthem. The "Lieutenant-Governor" was proposed by Mr. Buntzen. In the course of his remarks he said that as King Edward was called the first gentleman of England so might Sir Henri be called the first gentleman of British Columbia. Replying, Sir Henri expressed his pleasure at being present and at the honor conferred upon him and said that the occasion would long be associated in his mind with the last function at which he had presided, the opening of New Westminster bridge. Such feats as these were a credit to the province and he felt proud to be connected with them. He felt proud to think that the work of the tunnel had been done by local engineers and contractors.

The toast to the Dominion and Provincial Parliaments was replied to by Sir Chas. Hibbert Tupper and Premier McBride. A toast to the cities of "New Westminster, Victoria and Vancouver," was then drunk. "The B. C. Electric Railway Company" was proposed by Mr. J. C. Brown, of New Westminster, who alluded to the tunnel as the biggest "bore" in Canada. Mr. Buntzen was called on. The popular manager arose amid loud cheers, the heartiest of which seemed to come from those of the company's employees present. He referred to the tendency towards municipal ownership of electric plants. In the earlier life of a city it was not possible to finance these enterprises as well as a private company. Private capital could venture further and risk more than could a municipality. Mr. Buntzen referred to the excellent relationship existing between his company and its employees. This was one thing he was very proud of. In conclusion he voiced his regret at leaving British Columbia for London, whither he goes to occupy the highest position in the gift of the

EVERYTHING
ELECTRICAL

SAYER ELECTRIC
MONTREAL

directors, that of managing-director. He paid high tribute to his successor, Mr. R. H. Sperling.

The "London Directors" were then toasted. Mr. Francis G. Hope, the lately appointed secretary-treasurer of the company, from London, brought the directors' greetings. He stated that the directors were thankful to Mr. Meredith and Messrs. Herman & Burwell, the engineers for the work, but above all were they grateful to the fertile brain of Mr. Buntzen for his managment of the undertaking.

Hon. Mr. Carter-Cotton proposed the health of "The Men who Built the Tunnel," quoting from Milton. He said that "Peace hath her victories not less renowned than war," and he felt that the enterprise just completed would rank amongst the greatest of undertakings, and all honor was due to the men who engineered it through. Replying, Mr. Wynne Meredith spoke of the assistance rendered by both chief and men, and he was well satisfied to have but a part in the work. Mr. Herman and Mr. Reaume also replied.

The guests returned to Vancouver about 8 p.m. All present spoke in flattering terms of manager Buntzen and the officials of the companies.

THE TRAY PLATE STORAGE BATTERY.

Mr. P. B. Warwick, of the Tray Plate Storage Battery Company, of Binghampton, N.Y., is installing a Tray Storage Battery in the sub-station of the Shawinigan Water & Power Company at Montreal. This battery is unique and has a number of very desirable features. The elements are made in the form of pans or trays, the underside of each tray being the negative and the upper or inside being the positive. These trays are nested one in the other like a pile of tea saucers and are insulated one from the other by porcelain discs. The piles are surrounded and completely enclosed in heavy corrugated glass to prevent all chance of dust and foreign matter entering the trays.

The electrolyte is poured into the top tray and overflows into the next lower tray and so on until each tray is full, when the overflow is conducted into a lead-lined drip box. When the battery is being charged the electrolyte swells and overflows from pan to pan and finally into the drip box, whence it is transferred to the top pan again; in this way the electrolyte is maintaining an even density in every tray and the necessity of testing the specific gravity of each cell is obviated.

The small floor space is also another commendable feature, a tray having a capacity of 100 ampere hours requiring only a floor space of about 24 x 26 inches. The active material is held in close contact with the conducting support by a most peculiar method of spinning the lead on both sides of the plate at once, and consists of chemically pure electrolytic lead sponge or felt, compacted by being rolled under very heavy pressure. The method of preparing the lead sponge is a trade secret and is most zealously guarded by the Tray Plate Battery Company.

It is quite different to the regular method of pasting on a mixture of red lead and acid and water. By the peculiar construction of the elements the washing and wasting action is done away with and the trays slowly increase in capacity instead of decreasing, the reason for this being that the positive electrode being in the form of a pan or tray, the active material, even if as soft as mud, is in intimate connection at all times.

With the exception of the two terminals there are absolutely no connections or jumpers, one side of tray being the negative of one cell and the other side of same plate being the positive of the next cell or tray above. This method very materially reduces the resistance of the battery and allows of an extremely heavy discharge without injury to the battery.

The Tray Plate Battery Company have batteries in various parts of the United States and also in foreign countries that have been in use for upwards of three years, and all show an increased capacity. A few plants are here given: Broome County Buildings, Binghampton, N.Y.; Waterworks, Binghampton, N.Y.; Central Iron & Steel Works, Harrisburg, Pa.; Telephone Exchange, Greenville, Alabama; Hotel German, New Tripoli, Pa.; Walters Sanitarium, Walters Park, Pa.; Walters Sanitarium duplicate plant; Textile Machine Works, Wyomissing, Pa., three orders, and many others having over 10,000 cells in use.

The Company have also made a small storage battery for automobile ignition of a very novel and pleasing style. The cells only measure 4½ x 2½ x 7 inches and are made of translucent celluloid and are absolutely sealed with the same material. They have all the advantages of glass jars but are practically unbreakable. During the season of 1904, a Pope Toledo 4-cylinder 59 h.p. car averaged 2,650 miles on one charge with a set of this make of cell.

THE CANADIAN WHITE COMPANY.

The Canadian White Company, Limited, has been incorporated in Canada to carry on a general contractingand engineering business, on similar lines to J.G. White & Company, incorporated, of New York; J. G. White & Company, Limited, London, England.

The letters patent of the Canadian company were granted the latter part of May and the organization of the compay is now being completed.

The Canadian White Company, Limited, will carry on a general contracting and engineering business and will undertake any civil, mechanical, electrical, hydraulic and building work. It will be fully equipped to handle large construction contracts for steam or electric railways, and will be prepared to design, build, equip and operate electric lighting plants and power installations, gas works, water supply, sewerage systems, piers, docks, harbor works, office buildings, apartment houses, hotels, etc.

The contracting and engineering departments of J. G. White & Company, incorporated, of New York, will at all times be at the service of the Canadian Company and the company will further have the benefit of the experience of J. G. White & Company, Limited, London, England, and the Waring-White Building Company, London, England. This insures the Canadian Company from its inception, the benefits and advantages to be derived from a very long and successful experience in the contracting and engineering business.

The Canadian White Company, Limited, will have upon its Board as stockholders, strong representative business men well-known throughout Canada, and will be organized to carry on its business in the most thorough and expeditious manner.

The general manager of the Company will be a prominent civil engineer with large experience in railway construction, etc., and who has held executive positions.

Mr. H. P. Douglas, formerly vice-president and general manager of the Canadian Otis Elevator Company, Limited, will be treasurer of the Company.

The contracting and engineering staff will be sufficient at all times to carry out promptly and efficiently all works undertaken by the Company. The men for this department will be competent engineers who have had long and thorough experience.

Mr. H. C. Hitch has been engaged as superintendent of building construction. Mr. Hitch has been for several years connected with the Thompson-Starrett Company, of New York, as superintendent. Recently he has had full charge of the erection for the Thompson-Starrett Company of the Union Bank Building at Winnipeg.

The organization as outlined above, with its allied interests, insures prompt and efficient attention to any contracting or engineering matter that may be brought to its attention.

The Canadian White Company, Limited, intends making a feature of building construction, and is now prepared to contract for the better class of building work, such as office buildings, apartment houses, hotels, industrial plants, warehouses, etc.

The Company invites correspondence on all contracting, engineering and building propositions and will be glad at all times to investigate and report upon any business that may be brought to its attention.

IS THE TURBINE BUSINESS GROWING?

That the steam turbine is rapidly increasing its foothold in the power field is evidenced by the remarkable increase in manufacture of the well-known Westinghouse-Parsons type. During the six months ending June 30th, 1905, the Westinghouse Machine Company, exclusive builders of the Westinghouse-Parsons type, have contracted for no less than 82,000 kilowatts in turbo-generating machinery, averaging nearly 1,175 kw. capacity per turbine unit. These machines range in size from 200 kw. to 7,500 kw. The latter will be the largest turbines in the world, and three units of this size are under contract for Greater New York railway and lighting power stations. In the distribution of these among the various industries, the electric railway has claimed the largest number of machines, averaging 1,496 kw. in capacity; next in order, industrial plants, averaging 571 kw. capacity, and light and power plants, averaging 1,529 kw. capacity. In the order of total capacity, railway plants have required 38,900 kw., lighting plants, 26,300, industrial 12,000, miscellaneous 4,800.

This list bears excellent witness to the increasing possibilities of the turbine, and presages a brilliant future. The equipments noted represent solely actual sales only, and not including contemplated business or partially closed contracts.

The new buildlng to be erected by the Bell Telephone Company in Brantford, Ont., will be located on Dalhousie street and will cost about $40,000. A central energy switchboard will be installed.

The British Columbia Telephone Company are extending their system from Vancouver across Burrard Inlet to North Vancouver where a small exchange will be put in operation. The Company have secured 40 subscribers already in the municipality.

SPIRAL LAMP GUARDS and
OTHER MAKES

SAYER ELECTRIC
MONTREAL

AN ATTRACTIVE DISPLAY.

The Sayer Electric Company, Beaver Hall Hill, Montreal, had an attractive electrical display as a welcome to the Canadian Electrical Association, which convened in that city last month. Besides the electric lettering, the front of their store was beautifully decorated with flags and bunting. Notwithstanding that Montreal is designated an "electric city," the Sayer Company was the only firm to electric light their premises in honor of the convention.

DISPLAY OF THE SAYER ELECTRIC CO., MONTREAL.

C.G.E. APPARATUS.

The Canadian General Electric Company's exhibit at the Canadian Electrical Association Convention in Montreal last month was representative of the large line of electrical apparatus and supplies which they manufacture. The display was attractively arranged and was the subject of much favorable comment. Their headquarters were in the Windsor Hotel.

The Canada Foundry Company, Toronto, have just issued Bulletin No. 29 relating to single and duplex steam pumps. It gives a great deal of information about the operation of these pumps for the handling of fluids against ordinary pressure and for general purposes.

The Robb Engineering Company has received from Ahearn & Soper, Limited, Ottawa, an order for a 50 horse power engine for the Dunlop Tire Company, Toronto.

The Golden Electric Light Company, Golden, B.C., have placed an order with the Robb Engineering Company for an 80 horse power engine and boiler.

THE BABCOCK & WILCOX BOILER.

As an evidence of the growing favor with which the well-known Babcock & Wilcox boiler is being regarded in the Dominion of Canada, we may state that the following are among the many recent orders received: Canadian Pacific Railway Company, Montreal shops, 1,400 h.p. additional, equipped with Babcock patent superheaters and automatic chain grate stokers; Winnipeg City Water and Electric Light Plant, 500 h.p., equipped with Babcock patent superheaters and automatic chain grate stokers; Winnipeg Electric Railway Company, 2,000 h.p., equipped with "Neemes" patent shaking grates, etc.; Dominion Coal Company, Limited, 2,500 h.p.; J. R. Booth, Ottawa, 2,000 h.p., boilers and superheaters; Belgo-Canadian Pulp & Paper Company, 500 h.p.; Central Electric Company, Montreal, 200 h.p. additional; C.P.R., Winnipeg Hotel and Station, 800 h.p.; C.P.R. shops, Winnipeg, 1,500 h.p., with superheaters; Canada Car Company, Limited, Montreal, 1,800 h.p., with superheaters; Calgary City Electric Lighting Plant, 500 h.p., with "Neemes" shaking grates; F. W. Bird & Son, Hamilton, 75 h.p.; South Western Traction Company, London, Ont., 900 h.p.; Singer Manufacturing Company, St. Johns, Que., 1,625 h.p. We might also mention that the Dominion Government last fall installed Babcock & Wilcox marine boilers in the Dominion icebreaker "Montcalm," which was used so successfully in breaking the ice on the St. Lawrence during the past winter. The Babcock & Wilcox Company are also installing an additional economizer and induced draft plant for the Canadian Pacific Railway at Fort William.

The annual meeting of the Electrical Trades Association of the United States and Canada took place in Montreal on June 23rd.

The annual picnic of the employees of the Montreal Street Railway Company will be held at Riverside Park from August 14th to 20th inclusive.

The Provincial Telephone Company, Limited, has been incorporated by the New Brunswick Government to construct and maintain telephone lines throughout the county of Victoria. The capital stock is $9,000, and the promoters include Mr. Donald Fraser, of Fredericton, and Mr. Alexander Straton, of Andover.

CONDUITS COMPANY LIMITED TORONTO, CANADA
"CONDUITS" "GALVADUCT" "LORICATED"

"GALVADUCT" AND "LORICATED"
CONDUITS
FOR INTERIOR CONSTRUCTION
Conduits Company Limited
Sole Manufacturers under Canadian and U. S. Letters Patent
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GOOD GOODS and QUICK SHIPMENTS try
SAYER ELECTRIC
MONTREAL

Canadian White Company, Limited
SOVEREIGN BANK BUILDING, MONTREAL, CANADA
ENGINEERS AND CONTRACTORS
FOR
Steam and Electric Railroads; Electric Light and Power Plants; Building Construction; Water and Gas Works; Docks, Harbor Works, etc., etc.
CORRESPONDENTS
J. G. WHITE & COMPANY, INC., New York City
J. G. WHITE & COMPANY, LIMITED, London, England
WARING-WHITE BUILDING CO., London, England

THE BRITISH COLUMBIA TELEPHONE COMPANY.

The British Columbia Telephone Company has figured very prominently before the local public during the past month. Some time ago, as announced in the ELECTRICAL NEWS, this company decided to put in an underground system of wires in the business centre of the city of Vancouver. Plans were prepared and the route laid out on paper, all of which was duly submitted to the City Engineer for his approval and signature. This being obtained the Telephone Company immediately set to work on the undertaking. About this time the City Council, headed by the Mayor, got busy and raised an objection to the tearing up of the streets. And then began a merry war. The Telephone Company relied on their charter and the aforementioned approval of the City Engineer. The City Council claimed that, as their consent to tearing up the streets had not been obtained, the act was illegal. Counsel for each were retained and the matter was carried into the courts. Here the matter was argued out but owing to adjournments and other legal tardiness some time elapsed. In the meantime the Telephone Company's men had started to work and were busily engaged in carrying things to a finish when a detachment of policemen appeared and stopped operations for that day by arresting Superintendent Kent, of the Telephone Company, and the workmen who were on the work. They were brought to the police station and the usual preliminaries gone through, after which they were released on their own recognizances. When the case appeared before the local magistrate it was dismissed.

The men were immediately started to work again by the Telephone Company and were again stopped by the police, acting on the Mayor's orders, and the superintendent again arrested. A second time the charge laid against him was dismissed. Suits for false arrest were then filed against the city by Mr. Kent and several of the workmen. A counter suit for alleged defamation was also filed by Mayor Buscombe.

In the meantime the rights and privileges of the company to continue the work of tearing up the streets to lay underground wires, was being fought out in the courts before Mr. Justice Morrison. The legal contest finally resulted in Judge Morrison finding that the Telephone Company are perfectly within their charter rights in opening up trenches in lanes and streets along the route approved by the City Engineer, in order to lay their wires underground.

The Telephone Company have therefore resumed the work and at the time of writing are busy rushing the work to completion. It is hoped to have it finished long before the city can prepare its appeal to the Full Court to overrule the decision of Mr. Justice Morrison, provided the city decides to carry the matter further.

Barton & Company, manufacturers of motors, etc., London, Ont., have been succeeded by the Maple Leaf Automobile and Electrical Manufacturing Company.

BRITISH COLUMBIA STATIONERY ENGINEERS.

The second annual meeting of the British Columbia Association of Stationery Engineers was held at Victoria on May 12th. The delegates in attendance were: From Vancouver, No. 1, W. R. McClellan, C. A. Berry, Joseph Parks, Robert Graham and G. W. Anderson; from Victoria, No. 2, M. Hutchison, A. M. Aitken, F. M. Jones and P. Gordon; and from Nanaimo, No. 3, G. W. McKenzie.

The new officers of the grand lodge are: Grand chief, C. W. Ross, Victoria; grand vice chief, G. W. McKenzie, Nanaimo; grand treasurer, W. Reese, New Westminster; grand secretary, W. A. Robertson, Vancouver; and grand door guard, Robert Graham, Coquitlam.

The retiring officers were: Grand chief, W. H. Paddon, Vancouver; grand door guard, T. H. Rankine, Nelson; grand vice chief, C. W. Ross, Victoria.

The Victoria lodge entertained the visitors to a banquet in the Victoria Hotel which was much enjoyed.

The Bell Telephone Company have recently completed two additional lines between Ottawa and Montreal.

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Graduate Electrical and Mechanical Engineering. Theoretical and practical man, has been employed in a leading position by Canadian firm. First-class designer and tester of Electrical Machinery and Switchboard Work, Power Plants, etc. Five languages. Apply Box 27, ELECTRICAL NEWS, Toronto, Ont.

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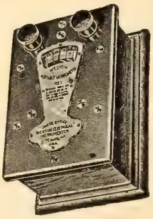

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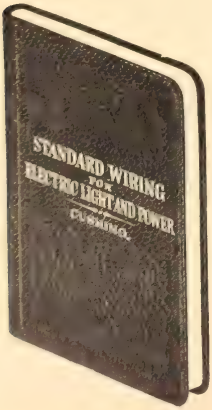

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THREE HANDSOME CARS.

Three new cars have just been turned out of the British Columbia Electric Railway's car shops at New Westminster. They are being used on the new Steveston line. The cars are named Eburne, Richmond and Steveston, each after one of the stations on the road. The interior fitting of the cars are handsome in the extreme. Australian Mahogany has been used and the transoms at the top of the windows are of beautifully stained glass. The seats are upholstered in Rattan with bronze handles. The cars are built with an eye to affording passengers every opportunity of surveying the surrounding country. They are divided into two compartments. They are 52 feet long over all and 32 feet inside. Four Canadian General Electric No. 67 motors, 50 h. p., are used on each car.

A new work car has also been built for this line. It is somewhat of a new departure along this line. An octagon cab for the motorman is placed in the centre of the car but raised up from the floor of the car 2 feet 6 inches thus permitting the carrying of poles or rails. This is an idea of the superintendent, Mr. T. Driscoll, and is quite an improvement over the old style of work car.

PACIFIC COAST EXCURSIONS.

During June, July, August and September the Chicago and North Western Railway will sell from Chicago round trip excursion tickets to San Francisco, Los Angeles, Portland, Ore. (Lewis & Clarke Exposition), Seattle, Victoria and Vancouver at very low rates. Correspondingly cheap fares from all points in Canada. Choice of routes, best of train service, favorable stopovers and liberal return limits. Rates, folders and full information can be obtained from B. H. Bennett, General Agent, 2 East King St. Toronto, Ont.

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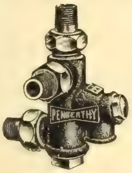

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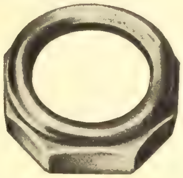

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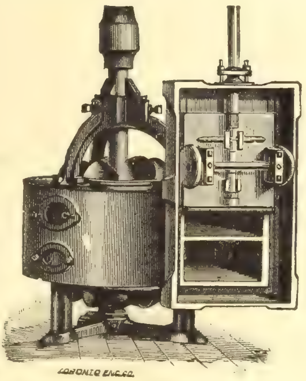
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PUBLICATIONS.

Kindly mention the CANADIAN ELECTRICAL NEWS when writing for any of the catalogues referred to below.

The Wellsman-Seaver-Morgan Company, of Cleveland, Ohio, have just issued a very comprehensive catalogue of ore and coal handling machinery, which will be found of much interest, and particularly to those contemplating the erection of plants for the unloading, conveying or storage of ore, coal or other loose material. There are some excellent interior views of their extensive plant at Akron.

The Canadian Westinghouse Company, of Hamilton, prepared for and distributed at the recent Canadian Electrical Association convention a very artistic publication illustrating and describing the various lines of apparatus manufactured at their works at Hamilton, Ont. Copies of the book, which is a very creditable production, may be obtained by making application to the general offices of the company.

The Koerting two Cycle Gas Engine is elaborately illustrated and described in the latest catalogue issued by De La Vergne Machine Company, sole licensees for the United States, East 138 street, New York. The modern Koerting gas engine presents an exterior appearance closely resembling the modern steam engine. It has many mechanical advantages and is claimed to have attained an advantage in thermal efficiency of at least 100 per cent. over the average steam engine.

A mailing booklet entitled "The Law of Employers' Liability" has reached us from The Consolidated Engine-Stop Company, manufacturers of the Monarch system of automatic devices, 100 Broadway, New York. There are four pages in two colors, with a three-color cover representing the cover of a book. The back cover extends above the front to accommodate the head and shoulders of a judge, which, being cut out, gives the booklet a novel form. The contents is a decision rendered by Judge Douglas in the Supreme Court of Rhode Island which is a tribute to the Monarch engine-stop and speed limit system.

AN ELECTRICALLY EQUIPPED TUG.

The tug, Sea Lion, owned by French & Robertson, Vancouver, B.C., has been equipped with a complete electric lighting system. A 6 kw. direct cnnnected dynamo run by a separate engine furnishes the power. The plant includes, besides the regular lighting equipment, double mast headlights, side lights, binnacle lights and towing lights, also an electric ventilating fan.

The searchlight is the largest on the Pacific Coast, being a 16-inch mirror reflector. All the lamps are made of brass. This light is operated direct from the pilot house. It is of a strength equal to 20,000 reflected candle power. The Sea Lion's electrical equipment was executed by the Hinton Electrical Company, of Vancouver and Victoria. It is the largest electrically equipped tug on the North Pacific. The Hinton people have also installed electric lighting plants in the tugs Belle, Active and Etta White, all owned by the Hastings Sawmill Company.

The shareholders of the Conn Telephone Company at a meeting at Shelburne, Ont., last month endorsed the scheme to have the capital stock increased to $40,000. It is proposed to extend the system to Arthur, Fergus, Drayton, Mount Pleasant and other points.

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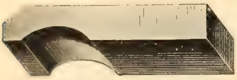

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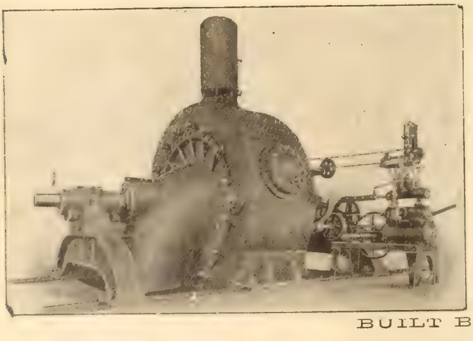

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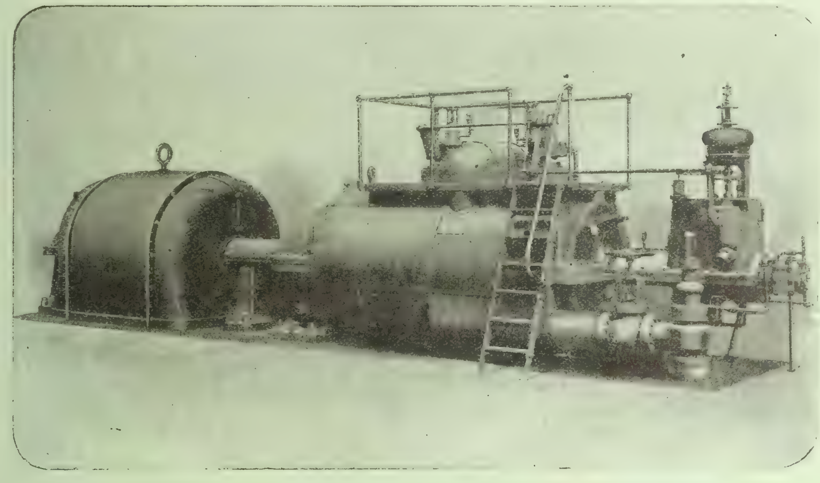

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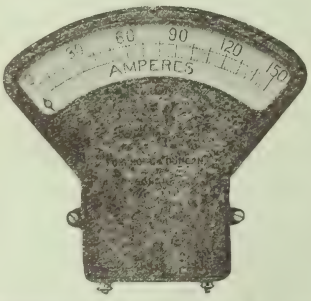

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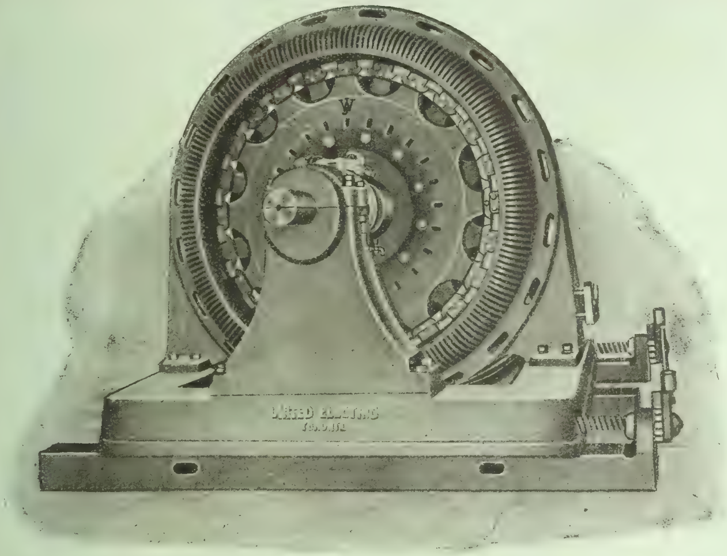

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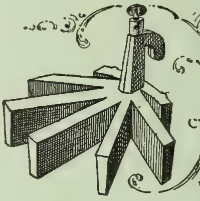

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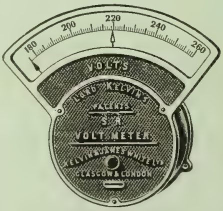

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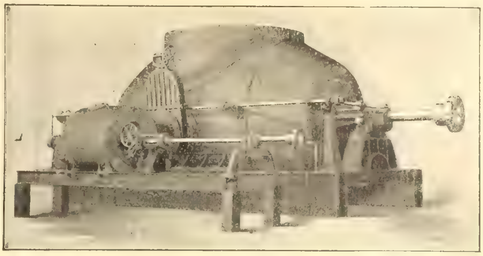

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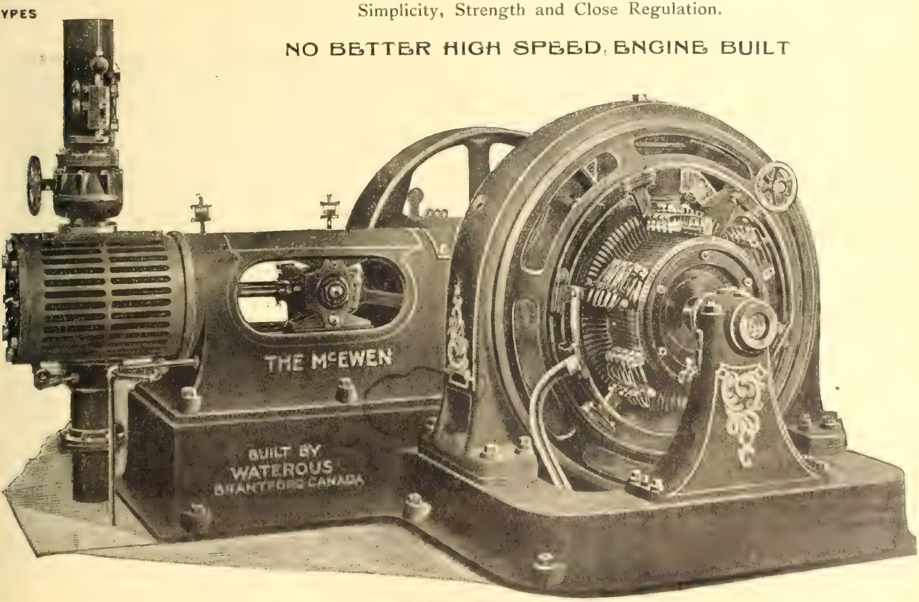

WATEROUS. BRANTFORD. CANADA

PERSONAL.

Mr. Thomas Rodgers, who has been an official of the Great Northwestern Telegraph Company at Montreal for many years, has resigned, and will join the staff of the C.P.R. Telegraphs.

Mr. Alfred C. Parkin, of Gravenhurst, Ont., has been appointed superintendent of the electric light plant owned by the Corporation of Dauphin, Man. His salary is $100 per month.

Mr. L. M. Hayden, superintendent at Rossland, B.C., for the West Kootenay Power & Light Company, was electrocuted on August 4th, as the result of the current being accidentally turned on too soon, before Mr. Hayden had finished repairing some wires.

Mr. J. A. Kammerer, of Toronto, widely known by the electrical fraternity, left last month with his wife for a pleasure trip to Japan. He expects to be absent about six months, and will doubtless acquire much information about electrical matters in that interesting country.

Prof. E. Brydone Jack, late of the University of New Brunswick, Fredericton, N.B., has been appointed professor of civil engineering at Dalhousie College, Halifax, N.S. He succeeds Prof. Dixon, who has been called to the chair of civil engineering at the University of Birmingham.

SPARKS.

The Kootenay Lake Telephone Company are building a new exchange at Nelson, B.C.

Messrs. Hiram Walker & Sons, Limited, are about to install a telephone system connecting their business places.

The British Columbia Telephone Company are rebuilding their line between Phoenix and Cascade, a distance of 25 miles. They intend also building an exchange on Seymour street, Vancouver.

The Burgessville Telephone Company of Ontario, Limited, has recently been organized, with head office at Burgessville, Ont. The directors are Messrs. Martin Emigh, J. G. Corless, H. E. Service, Henry Sneath, and William T. Nutt.

Mr. C. A. Gass has sold out his telephone business at Moose Jaw, N.W.T., to the Moose Jaw Telephone Company, Limited, of which Mr. Charles Thomas is manager. The company will spend about $10,000 in reconstructing the system.

Before the Parliamentary Committee at Ottawa, Mr. J. H. Winfield, manager of the Nova Scotia Telephone Company, stated that that company had about 2,360 instruments and that there was a telephone to every 74 persons in the province of Nova Scotia. The farmers in Nova Scotia did not use telephones, according to the experience of his company.

The telephone exchange in Campbellton, N.B., owned by the Restigouche Electric & Telephone Company, has been sold to the Central Telephone Company. The new owners have their headquarters at Sussex. They intend installing new 'phones, putting in a metallic system of wiring, and giving Campbellton an up-to-date service locally, as well as connection with other parts of the province.

CLARKSON SCHOOL OF TECHNOLOGY
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Organized under charter of the University of the State of New York.
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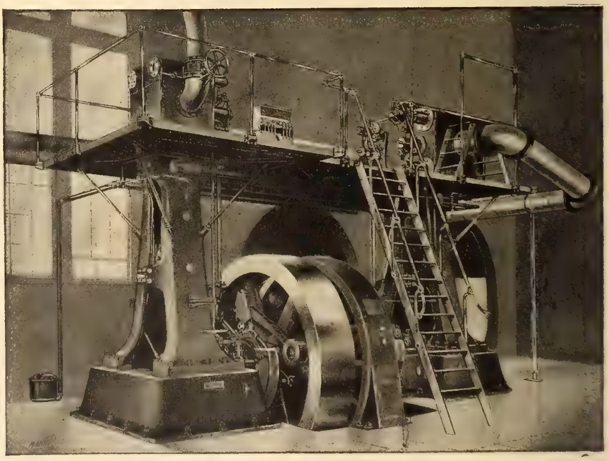

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AGENTS { WILLIAM McKAY, 320 Ossington Avenue, Toronto.
WATSON JACK & COMPANY, Bell Telephone Bldg., Montreal.
J. F. PORTER, 355 Carlton St., Winnipeg.

TRADE NOTES.

The Robb Engineering Company has received an order from the Allis-Chalmers-Bullock, Limited, for a 75 horse power engine for the C. P. R. shops at Moose Jaw.

The Hill Electric Switch Company, Montreal, have received contracts to construct switchboards for the C. P. R. at Brandon, Man., and the Valleyfield Electric Light Company at Valleyfield, Que. The latter order was placed by John Forman.

The United Electric Company have been compelled to move their factory on account of the property which they occupied on Niagara street having been purchased. They are moving into the factory on King street west formerly occupied by Cowan & Company and will eventually move their offices also to this building.

During the latter part of July a new firm—McLean & Sophus—commenced business at 301 St. James street, Montreal, as mechanical engineers and machinery merchants. Mr. McLean is a Canadian and an old McGill Boy, having graduated in 1899, carrying off the 1851 scholarship, after which he carried on research work at the Victoria University (then Owen's College), Manchester, England. For a number of years he has been connected with a well-known firm of engineers of that city, until now he has returned to his native land. Mr. Sophus has been connected with a firm of electric wire and cable makers in Manchester, England, for four years ending December, 1904, and his experience in a works of this kind will ensure the safe handling of the electrical goods which the firm will carry. A specialty is being made of reduction gearing for electric motors, etc., both spur and worm gears; also standard and limit gauges for machine-shop use.

Tenders are invited by the city of Vancouver, B.C., up to August 14th, for an electric lighting system to consist of 350 lamps or more. Tenders will be considered for 9.6 ampere direct current and for 7.5 ampere series alternating enclosed arcs. The contract will be awarded for a term of five or ten years.

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¶ Water Wheel Plant consisting of pair of our 30 in. Crocker Turbines horizontally set in central discharge Steel Case. All complete with Draft Tube, Driving Pulley and Woodward Governor.

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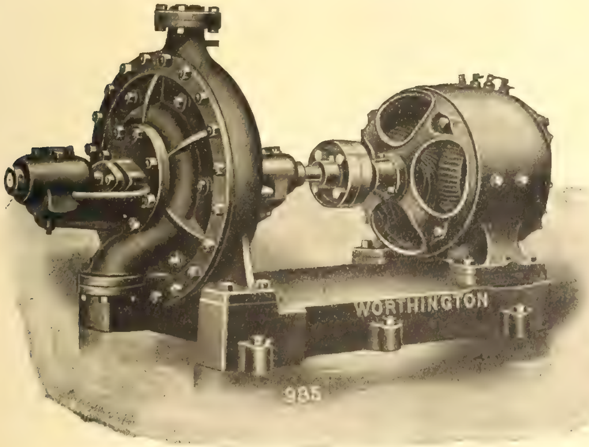

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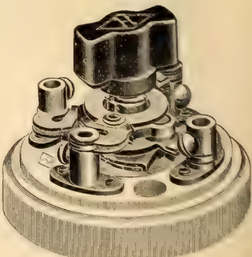

PUBLICATIONS.

Kindly mention the CANADIAN ELECTRICAL NEWS when writing for any of the catalogues referred to below.

The Great North-Western Telegraph Company have issued a general reference book, which contains a list of officers, rates, connections, etc., and should be found very useful to patrons of the telegraphic service.

The latest catalogue from Messrs. J. G. White & Company, engineers and contractors, New York, is designated "Interurban Railway Construction". It shows a number of splendid plants installed and other works executed by this company.

A booklet describing the Koerting gas engines has been received from De La Vergne Machine Company, 138th street, New York. A view is shown of a 40,000 h. p. installation of two-cycle engines operating direct and alternating current generators in parallel.

"The Insulator Book" is the title given to catalogue No. 8 issued by the Locke Insulator Manufacturing Company, of Victor, N. Y. The catalogue brings before the engineering world the types of insulators which are recognized as best adapted to the conditions of various climates.

The Crocker-Wheeler Company, of Ampere, N.J., have reprinted an article entitled "An Electrified Railway Shop," prepared by Mr. Roy V. Wright, then mechanical engineer of the Pittsburg and Lake Erie Railroad. Mr. Wright is now associate editor of The American Engineer & Railroad Journal.

A thoroughly practical book has been placed on the market by Longmans, Green & Company, 39 Paternoster Row, London, E.C. It is entitled "Mechanics for Engineers", the ground covered being that required for the intermediate examination of the University of London in mechanics. The price of the book is four shillings.

The Canadian General Electric Company have issued Section 4 of their Supply Catalogue. Although devoted entirely to switches, it contains 84 pages and upwards of 150 illustrations, making perhaps the most extensive and complete catalogue of the kind which has ever been published. Flush, knife and snap switches are shown in a very wide range.

The Canadian Buffalo Forge Company, of Montreal, have issued the 1905 edition of their general catalogue, which describes and illustrates the large line of machinery and apparatus which they manufacture, including Buffalo forges, blacksmiths' tools, power blowers and exhausters, heating and ventilating pumps, disc wheels, armour-plate handle cutters, etc.

MOONLIGHT SCHEDULE FOR SEPTEMBER.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Sept. 1	7 00	Sept. 2	4 30	9 30
2	7 00	3	4 40	9 40
3	7 00	4	4 40	9 40
4	7 00	5	4 40	9 40
5	7 00	6	4 40	9 40
6	10 00	7	4 50	6 50
7	11 00	8	4 50	5 50
9	0 00	9	4 50	4 50
10	0 50	10	4 50	4 00
11	1 50	11	4 50	3 00
12	2 50	12	4 50	2 00
13	No Light	13	No Light	
14	" "	14	" "	
15	6 40	15	8 50	2 10
16	6 40	16	9 20	2 40
17	6 40	17	9 50	3 10
18	6 30	18	10 20	3 50
19	6 30	19	11 00	4 30
20	6 30	20	11 40	5 10
21	6 30	22	0 30	6 00
22	6 30	23	1 20	6 50
2	6 20	24	2 20	8 00
24	7 20	25	3 20	9 00
25	6 20	26	4 30	10 10
26	6 20	27	5 10	10 50
27	6 20	28	5 10	10 50
28	6 20	29	5 10	10 50
29	6 10	30	5 20	11 10
30	6 10	Oct. 1	5 20	11 10
			Total............	191 00

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During June, July, August and September the Chicago and North Western Railway will sell from Chicago round trip excursion tickets to San Francisco, Los Angeles, Portland, Ore. (Lewis & Clarke Exposition), Seattle, Victoria and Vancouver at very low rates. Correspondingly cheap fares from all points in Canada. Choice of routes, best of train service, favorable stopovers and liberal return limits. Rates, folders and full information can be obtained from B. H. Bennett, General Agent, 2 East King St. Toronto, Ont.

SPARKS.

Mr. E. H. Farrow, for some years local manager of the Bell Telephone Company at Belleville, Ont., has been succeeded by Mr. Dyke, of Lindsay. Mr. Farrow has joined the construction department of the company.

The North Wellington Telephone Company, Limited, was incorporated last month. It is proposed to construct and operate a telephone system in the counties of Wellington and Dufferin and to have the head office at Arthur. Mr. J. M. Roach, of Arthur, is one of the promoters.

STEAM PLANTS

We can supply complete steam plants for any purpose. This will include **Engines** (Wheelock, Corliss or the Ideal high speed), **Boilers, Condensers, Pumps, Heaters, Piping, Valves** and all other accessories. We make a specialty of Electrical Power Plants.

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This Holder is made in two parts, consisting of a Slit Screw Collar and Holder.

It may be attached to any standard socket without the use of tools, and is as firmly held in place as if it were a part of the shell itself, holding the shade or globe in a direct or true center, and its rigidity prevents (by ill use or otherwise) the shade from being sprung from a correct position.

There are no projecting screws or lugs to present an unsightly appearance.

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STEEL CABLES.

In power transmission work spans have occasionally to be dealt with which cannot be carried out with copper conductors, and resort has then to be had to steel cables. The use of such cables would appear to involve an excessive drop. In order to investigate the matter the Allgemeine Elektricitats Gesellschaft has recently carried out some experiments, the results of which show that the drop with alternating currents is not so much in excess of that obtained with direct currents as might have been expected. The difference increased with the cross-section of the conductor and the current, and decreases, for a given total cross-section, as the strands are made smaller and more numerous.

THE CANADIAN NATIONAL EXHIBITION.

One of the leading attractions of the Canadian National Exhibition in Toronto since its inception has been the Process Building, in which are shown a score and more of producing industries in actual operation. Among other manufactures shown this year will be a complete demonstration of the manufacture of pure food, illustrations of the various forms of textile manufacture, complete boot and shoe making, manufacture of Canadian tweeds and other cloths, spring beds and other articles of domestic use, silk weaving, printing, lithographing with the latest presses and machines, type-setting, binder-twine making, and so on, making, undoubtedly, one of the most interesting attractions ever offered at any exhibition, as well as one of the most instructive. The Exhibition will this year be held from August 26th to September 11th.

The town of Revelstoke, B. C., has ordered a 2,000 light alternator, including switchboard and exciter, from the Canadian General Electric Company.

SPARKS.

The New Brunswick Telephone Company held their annual meeting at Fredericton June 13th, when it was decided to proceed at once with the erection of a new exchange at Fredericton, to cost about $6,000. The following officers for the ensuing year were elected: President, Hon. A. G. Blair; vice-president, J. L. Black; treasurer, Hon. F. P. Thompson; secretary, W. E. Smith.

Bath, N.B., is well provided with telephones, there being four companies doing business there, namely Michael Welch Telephone Company, New Brunswick Telephone Company, Union Telephone Company and Consolidated Telephone Company.

The exceptionally warm season has resulted in an avalanche of orders for desk and ceiling fans. The Electric Engineering Company, who are agents for the Century Electric Company, of St. Louis, Mo., have already placed more than thirty ceiling fans this season, not to mention the quantities of 12" and 16" desk fans for alternating current. This concern are also doing a large business in single phase motors ranging from one to five horse power, adapted for any frequency from 25-133 cycles. They handle also the Robins and Myres direct current ceiling and desk fans, for which there has been a very active demand this season.

The Toronto and Niagara Power Company have arranged to extend their lines for power transmission into Western Ontario. Mr. Frederic Nicholls, manager of the company, recently gave the following statement of the proposed plans: "The company has arranged to extend its power lines westward as far as London, touching at Brantford, Paris, Woodstock, Ingersoll and other points on the way. The company also intends to build branch lines to Galt, Preston, Hespeler, Guelph, Berlin, Waterloo, and other towns in the western peninsula. The works of the company at Niagara will be completed next year. The tail-race tunnel, wheel pit, head works, power-house, etc., are being constructed for the full output of 125,000 horse-power. At the start, water wheels and generators for one-half the capacity will be installed, but as everything else for the full output will be complete, it will take only a comparatively short time to add additional wheels and generators. Inasmuch as the works are not complete, no definite cost can be ascertained, but the company expects to be able to offer power at such attractive prices as will induce a good demand for it."

Pittsburgh Transformers.

Pittsburgh transformers are the best transformers made. If you are not already using them it will pay you to write for the price-list and proposal form. Better send for it anyhow, whether you are in the market or not.

Pittsburgh Transformer Company
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Packard

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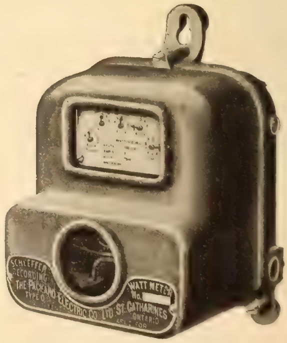
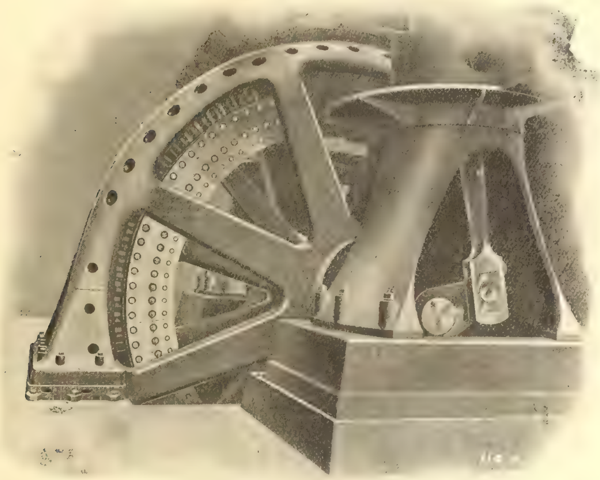


Type "G"

ALLIS-CHALMERS-BULLOCK

LIMITED



A 3,000 k. w. Bullock alternating current generator, flywheel type, direct connected to an Allis-Chalmers vertical cross compound engine.

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STEEL POLES
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EARS
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FIELD COILS

TROLLEY CORDS
INSULATING MATERIALS
CAR CURTAINS
TROLLEY POLES

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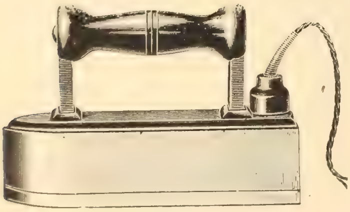

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THE BOOK-KEEPER
The Book-Keeper forgets to cuff
THE OFFICE BOY
The Office Boy never thinks now of kicking
THE DOG

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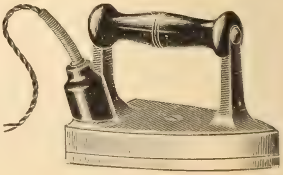

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AND
ENGINEERING JOURNAL

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THE FENELON FALLS MUNICIPAL POWER DEVELOPMENT

The first electrical equipment in Fenelon Falls was installed, about ten years ago, by Messrs. McDougall, Brandon & Austin, millers, the contract going to the Royal Electric Company. The generator was a 30 kilowatt, 1040 volt, 133 cycle, two-phase machine of the S.K.C. type and was driven by the water power located right in the heart of the village. In 1900 the plant was enlarged, a 75 kilowatt machine being substituted.

FENELON FALLS POWER DEVELOPMENT—FALLS AND POWER HOUSE.

Some years after this the Corporation made arrangements to take over the electric plant, the flour mill, and that portion of the water power owned by the McDougall concern, and actually took possession on September 1st, 1903, from which date the whole has been run as a municipal venture.

The water power of the Fenelon river is divided into sixteenths, as an old measurement placed the minimum flow at 1600 horse power. However, there is great storage capacity immediately behind the falls, and the available power is unquestionably much greater than this amount. With the mill property, the village acquired four-sixteenths of the flow of the river, or nominally 400 horse power, but conservative estimates placed the figure at approximately 750. Of the balance of the nominal power, the Lindsay Light, Heat & Power Company own eleven-sixteenths and the Sandford Furniture & Woodenware Company owned the remaining sixteenth but has lately sold it to the Village.

Under the stimulus of municipal ownership, the electrical business in Fenelon Falls moved forward very rapidly, and it was not very long before the authorities found that their 75 kilowatt machine was running over its rated capacity. The critical point was reached on December 1st, 1903, after which date no more lamps were taken on. This condition led to the consideration of a larger plant. There were demands for power, and as the village is on the route of the Trent Valley canal, and there was the possibility of having connection with two railroads, the Commissioners took the matter up, and decided to make a full development of their power at once. Figuring upon a minimum of 750 horse power, and considering that the flour mill required 150, this left 600 available for the proposed plant, and it was decided to install an equipment at once which would make possible the delivery of this full amount. A smaller development, more in keeping with the demands of the next few years, was considered, but as the cost was very little lower the idea was abandoned.

At the time of going into this question, the Village had no debt whatever, and besides was noted for having the lowest tax rate in the province, the figure being 15 mills, on an assessment of about 50% of real value. The Sandford Company, previously mentioned, agreed to build a larger factory if the Corporation would purchase preferred stock to the extent of $15,000, and it was estimated that $75,000 would be needed to buy the flour mill, the water power, and install the new electrical plant. This meant the assumption of a debt of $90,000, which was a serious matter for a village of 1,500 people. However, when the matter came before the ratepayers, it was heartily endorsed, and after some natural delay, the provincial authorities gave the movement their sanction.

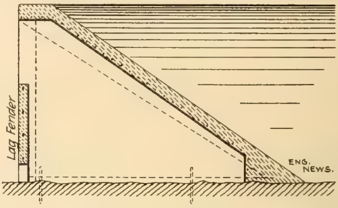
The designing of the plant was placed in the hands of a hydraulic engineer and an electrical engineer; specifications were issued and contracts awarded, the wing dam going to the Ambursen Hydraulic Construction Company, of Boston, Mass., the turbines to the Jenckes Machine Company, and the generator, exciter and switchboard to the General Electric Company, of Sweden, through their Canadian representatives, Read & Kilmer, of Toronto. The water wheels will deliver 600 brake horse power under a twenty-four foot head, and the generator has a capacity of 525 kilovoltamperes, with an 80 per cent. power factor.

The wing dam is of the "gravity" pattern, being built of reinforced concrete. Its length is 194 feet, and its height approximately 10 feet. One remarkable feature of this dam is that the entire work of construction occupied only 22 working days.

Fenelon Falls Power Development—View of Dam.

The actual date of starting the work on the plant was June 13th, 1904, and electrical energy was being delivered on January 5th, 1905. The property, including the water priveleges, but not including the flour mill building, cost the Corporation $20,000, and the entire cost of building the dam, power house, etc., and installing the machinery and equipping the distributing lines was $30,000.

The tax rate is now 17 mills, but this increase is due to the schools entirely. So far as the electrical plant is concerned, everything is in a very satisfactory shape. Of course, the load is not yet above 25 per cent. of the normal capacity, but with all fixed and running charges paid, the Village will have about $1,000 left out of the annual revenue. The rates for light and power are now low, but when the load increases, they will be made still lower. The plant has not been installed as a money-making venture, but rather with the hope of inducing manufacturing concerns to locate within the Corporation limits. If a large company should come there and employ a sufficient number of hands, power for practically nothing may be counted upon, and this is certainly an inducement. The bonus scheme is not approved of in the Village, but the substitute offered is certainly a satisfactory one.



Fenelon Falls Power Devepopment—Cross-Section of Dam.

At present there are about 1700 16 candle power lamps, one ten, and three fifty horse power motors connected.

The forebay, wheelpit, etc., are all built of concrete, and the power house proper is constructed of cement block. The power house is of the usual double storey design, the upper door being level with the streets, and the lower leading out somewhat above the level of the tail water. The building is twenty-six by thirty-one feet inside, and with the exception of the gallery, is open from the floor to the roof.

There are two thirty-five inch horizontal wheels, mounted on one shaft, and directly connected to the generator, the wheels being controlled by a Woodward governor. There is also a smaller turbine directly connected to the exciter.

The generator is of the three-phase, 550 volts, 60 cycle, revolving field pattern, and as before stated, has a capacity of 525 kilovoltamperes, at 80 per cent. power factor. While being a foreign built machine, it follows generally the standard practice of this country. The speed is 200 revolutions per minute, and consequently there are thirty-six poles. The exciter is of the slow speed, four pole type, running at six hundred revolutions, and giving a potential of 110. The capacity is fifteen kilowatts.

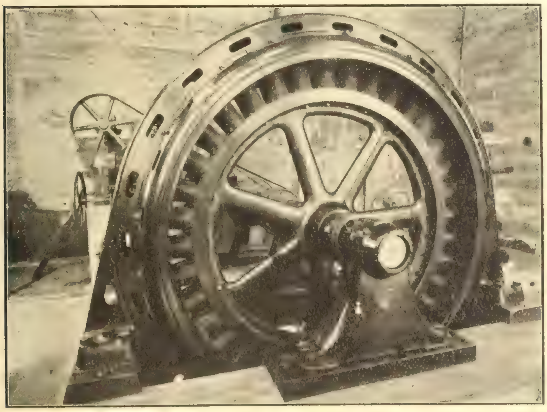
The switchboard is made up of three panels, one being for the generator and exciter, and the other two for feeder circuits. The generator panel contains the usual complement of voltmeter, three ammeters and indicating wattmeter, synchronizing lamps, etc., and also an ammeter for the exciter. The sub-panel contains the main switch, which is of the oil-break pattern. From each feeder panel run two circuits, each panel containing two air-break switches and two ammeters. The sub-panels are blank.

The plant operates continuously, except on Sunday, when it is shut down during the day time. The attendants are provided with record sheets, and hourly readings are taken of all meters, these records being submitted to the Secretary of the Board, and kept on file by him.

Up to the present time, the plant has had no trouble whatever, all having run smoothly since the date of starting. On the first official test, there was some apparent difficulty, for the equipment seemed unable to deliver more than 300 horse power. A great number of attempts have were to locate the trouble, but without success, until, at a very recent date, a wrong connection was found in one of the switchboard meters. It was thought at first that the wheels supplied by the Jenckes Machine Company did not come up to the guarantees, and this rumor was used by the company's competitors. This is very much to be regretted, as the Jenckes people were in no way to blame, for the last test made showed that their guarantees had been entirely fulfilled. The wrongly connected meter left the factory properly connected, and the mis-connection was made after the apparatus was installed. This all goes to show how much trouble may be caused by a very little thing.

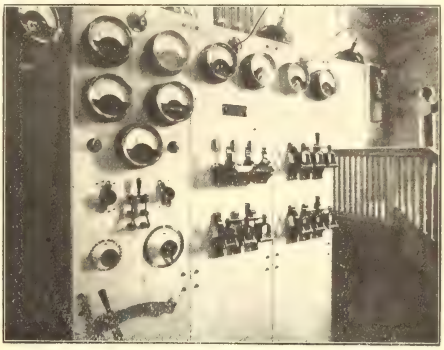
The Board of Water, Light and Power Commissioners of Fenelon Falls was composed last year as follows:—Dr. Gould (Chairman), M. W. Brandon, Geo. Martin, Jos. McFarland, and F. A. McDiarmid, Secretary-Treasurer. Only one change has been made so far, Wm. Burgoyne having taken Geo. Martin's place at the beginning of the year. To these gentlemen great credit is due for the way in which the installation of the plant was conducted. They may certainly feel justly proud of the work accomplished under their regime.

STREET LIGHTING.



Fenelon Falls Power Development—Generator.

At the annual convention of the Incorporated Municipal Electrical Association at Edinburgh, in June last, Mr. E. E. Hoadley, of Maidstone, presented an exhaustive paper on "Street Lighting." Concluding he said: "The author would like to say a word or two about the future of side-street lighting. With the Nernst lamp, the mercury-vapor lamp, the osmium lamp and later still with the tantalum lamp, he has no fear but that central-station engineers will be able to keep the business in their own hands. It behooves them all in these days of strenuous competition to do all that they possibly can to promote economy at both ends of the line—that is, in the cost of the production of energy and the efficiency of the light-giver—by giving careful thought and trials to these new appliances as they come along, and not always waiting for the results of someone else's experiments. The introduction of these newer lamps seems to the author to be of the highest importance, as it means the same amount of light as with the carbon-filament lamps for less than half the same expenditure of energy, and it is at this end of the line, he feels sure, that the greatest advances will be made, advances which will have much more effect on the final result than at the power station end, as he would be a bold prophet who would state that within the next few years a reduction of 50 per cent. will be made in the cost of production of the unit.



Fenelon Falls Power Development—Switchboard.

Personally, the author considers the Nernst lamp, although still far from perfect, to have been the saviour of the side-street lighting business for the electrical world; the chief improvements he would suggest in its manufacture are: That the burner should be made a more mechanical job, and that the actual filament when broken should be capable of easy replacement by the user at a cost of a few pence, instead of, as at the present time, the whole burner including the heating coil and its supports and connections being thrown away, at a cost of nearly 2s."

ELECTRIC SMELTING.

Experiments in electric smelting which are to be conducted at Sault Ste. Marie, Ont., will be commenced in about two months. Mr. Herault, of La Praz, France, inventor of the Herault system of smelting by electricity, will come to Canada to give the Government the benefit of his advice. Investigations so far made into the electric system of smelting and the valuable report published on the subject under the auspices of the Canadian Government have attracted world-wide interest, and no less than 2,500 commendatory letters from all quarters of the habitable globe have been received by Dr. Haanel, Superintendent of Mines.

NIAGARA POWER IN TORONTO.

The Toronto and Niagara Power Company propose to transmit 20,000 electric horse power from Niagara Falls to Toronto, which power will be generated by the Electrical Development Company. The transmission line terminates in a substation at the intersection of Davenport road and Huron street, close to the Canadian Pacific Railway, and just outside the city limits. From this site to the lake front in a direct line the distance is some 14,000 ft., and it lies about midway of the length of the city east and west. At this substation the pressure of the transmitted current is transformed from about 60,000 to some 12,600 volts, and the distribution at this latter pressure to other substations begins. This distribution extends to four main substations with converting as well as transforming equipments, and to several substations where only transformers are located. Two of these converting substations supply lamps and stationary motors, and two operate the electric railway system.

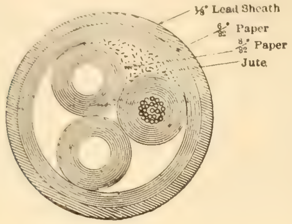


FIG. 1—12,000 VOLT, 3-PHASE CABLE AT TORONTO.

Electrical supply in Toronto was at one time carried on by competing interests, and this condition resulted in the erection of two steam-power stations, one on the lake front at the foot of Scott street and adjoining the tracks of the Canadian Pacific and Grand Trunk Railways, and the other on Terauley and Agnes streets, about 4,000 ft. from the railway and a little more than that from the lake. Between these two stations the distance is about 5,000 ft. and each one is within 3,000 ft. of the most compact business section of the city. Consolidation has brought these two stations under common management, and in each the power transmitted from Niagara Falls will largely, if not entirely, displace steam.

At the Scott street station on the water front, which was first in the field, the electric generating equipment includes direct-current, constant-pressure dynamos of 125 volts and 275 volts respectively, series arc dynamos, and 2,400-volt, 60-cycle, single-phase alternators. The 125-volt dynamos have an aggregate capacity of 1,200 k.w. in six machines, the 275-volt dynamos are the equivalent in capacity of 3,600 k.w., the six alternators are rated at 400 k.w. each, making their total 2,400,and there is a capacity for 2,000, 9.6-amp. open arc lamps, or about 1,000 k.w. in arc dynamos. These figures give the Scott street station a total dynamo capacity of 8,200 k.w. At the Terauley street station the equipment consists entirely of 125-volt, direct-current dynamos with a total rating of 1,000 k.w. From the Terauley street station there are operated incandescent and arc lamps, and motors on a 2 x 125-volt, three-wire system.

Four sorts of distribution service are supplied from the Scott street plant. The 125-volt dynamos there operate a 2 x 125-volt, three-wire system, mainly for commercial incandescent lamps. The 275-volt dynamos operate another three-wire system exclusively for motors, and these dynamos are used on the outside wires of the 2 x 250-volt circuits at times of heavy load. Single-phase, 60-cycle current is distributed for incandescent lighting, more particularly in the outlying districts of the city. Arc dynamos in the Scott street plant operate open arc lamps mainly for street lighting.

Some changes will be made in these lines of service with the introduction of Niagara power. The 2,400-volt, 60-cycle circuits will remain single-phase, as at present. Circuits of 2 x 125-volts, three-wire, are to be discontinued, and the 2 x 250-volt circuits are to supply both the lamps and motors, incandescent lamps of 250 volts being substituted for those now in use at about 125. In the central business portion of the city bounded by Bay, College and Sherbourne streets and Spadina avenue, both lamps and motors will continue to be supplied with direct current.

Toronto has a width of about 14,000 ft. at right angles to the lake front, and extends for more than twice that distance east and west. As there are many factories in the outlying portions of the city, a new motor service with three-phase, 25-cycle current at 600 volts is to be provided for scattered motor loads. Circuits for this service will be run from some four or five transformer substations located in various parts of the city, and as each of these substations will contain no moving machinery the constant presence of attendants will not be necessary.

The transformer station on Davenport road, near Symington street, will be connected with the terminal station by an overhead line along a course outside of the city limits. Underground cables from the Terauley street substation will deliver the 12,000-volt current to all of the other transformer stations except the one at the terminal station. From this terminal station the 12,000-volt current from the step-down transformers is carried by four lead-covered cables, which run first to the Terauley street substation, and then go on to the steam and substation at Scott street. In the Terauley street substation these cables connect with four 1,200-h p., 12,000-volt synchronous motors. Each of these motors is direct-coupled to a 400 k.w., 250-volt, direct-current dynamo at one end of the shaft, and to a 400-k.w., 2,400-volt, 60-cycle, three-phase alternator at the other end.

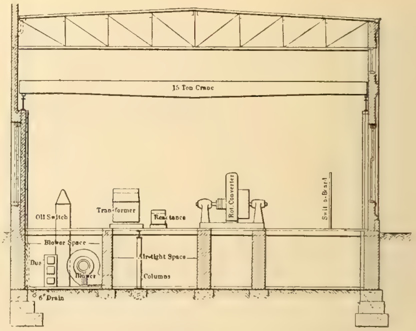


FIG. 2—CROSS-SECTION OF YONGE STREET SUB-STATION.

At the Scott street generating and substation the four cables connect with two banks of transformers that reduce the pressure from 12,000 volts to that for two 500-volt, 100-k.w., rotary converters. The total converting capacity at the two substations is thus 4,200 k.w. At the Scott street station there is also to be installed two Curtis steam turbines, each with an alternator rated at 2,000 k.w. and 12,000 volts, 25 cycle and three-phase. These turbine generators are intended as a steam reserve and it may be noted that their voltage limits their application to the converting equipments before noted, and to the transformers for motor service.

Each of the four cables that connect the terminal station with the several substations contains three copper conductors, each made up of 19 wires, with a combined cross section equivalent to No. 00 wire. About each of these three conductors there is a wrapping of paper ¼-in. thick, and around the group of three conductors there is a layer of paper 3-16 in. thick. Outside of this layer of paper comes the lead sheath with a radial thickness of ⅛-in., and an external diameter of 2⅝-in. Between the insulated conductors and the encircling layer of paper the spaces are filled with jute. The arrangement of the conductors and insulation is shown in Fig. 1.

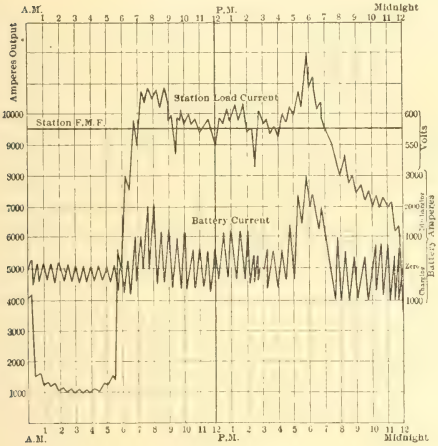


Fig. 3 Load Curves.

At the Terauley street sub-station the 250-volt dynamos will operate two in series on the three-wire system, and at the Scott street station the 500-volt rotary converters will be connected to the outside wires of the same system. The 2,400-volt, 60-cycle, three-phase alternators at the Terauley street sub-station will carry the lighting load in outlying districts. Arc dynamos will continue to operate the series circuits of street lamps, but these dynamos will in the future be driven by induction motors. Each of the sub-stations for motor service only will have a capacity of about 1,000 k.w. in transformers.

The present lighting load at Toronto, according to the Electrical World, from which these particulars are obtained, includes about 60,000 incandescent lamps on the direct-current, 2 × 250-volt main; 90,000 incandescent lamps supplied from the 2,400-volt, 60-cycle, single-phase lines, and the open, 9.6-amp. arc lamps operated by dynamos of 2,000 lamps capacity. About 1,200 direct-current motors, that range up to 110 h.p. each in capacity, are operated from the 250 and 500-volt, three-wire lines.

Another set of cables like those before named starts from the terminal station of the Toronto & Niagara Power Company, and runs by the way of Davenport road to a sub-station of the Toronto Railway Company on Yonge street. From this sub-station the cables pass along Yonge to Bloor street east, and thence to Sherbourne street, which they follow to the steam and sub-station of the railway at the lake front. The total length of this cable route is about 17,000 ft.

At the sub-station on Yonge street, a cross-sectional view of which is given in Fig. 2, the cables connect with three groups of transformers, each group consisting of three 350-k.w. transformers that reduce the voltage from 12,000 to that for a 500-volt, 1,000-k.w. rotary converter. At this sub-station the converters of 3,000 k.w. total capacity connect with the railway feeders. In the steam and sub-station at the water front the 12,000-volt underground cables connect with five groups of transformers, each group having a capacity of 1,050 k.w. and supplying current to 1,000-k.w. rotary converter. The combined capacity of converters at these two sub-stations is thus 8,000 k.w.

At High Park avenue it is probable that another sub-station, with a converter capacity of 1,000 k.w., will be located for the railway line in the west end of the city.

Across the street from the steam and substation on the water front, there is a battery-house with storage batteries of 4,000 amp-hour capacity at 550 volts. On the basis of one hour discharge rate this battery has a capacity of 2,200 k.w. Near the Yonge street sub-station is located another battery-house which will contain another battery of 4,000 amp-hour capacity for the street railway.

On February 14, 1905, the Toronto street railway was operated by the steam generating station, on the water front, and by the storage battery close to it. During the twenty-four hours of that day the average amperes delivered to the railway system from generators and storage batteries were 8,653, at 575 average volts. (See Fig. 3.) The maximum amperes delivered by the generators reached 12,000, the maximum battery load was 3,000 amperes, and the maximum load of the system was 15,000 amperes. The maximum generator load of 12,000 amperes at 575 volts represents 6,900 kilowatts. It seems, therefore, that the 8,000 k.w. in capacity of rotary converters to be installed at the steam generating station and in the Yonge street sub-station, together with the two storage batteries, will be somewhat in excess of present requirements.

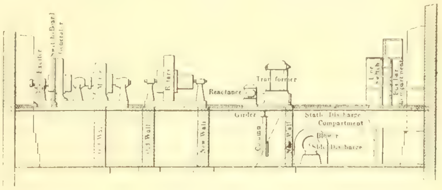


Fig. 4—General Arrangement of Front Street Sub-Station.

The two houses for the 4,000 amp-hour batteries are of nearly the same design, each being a one-storey brick building, with tile floor laid on concrete, and a tar and gravel roof supported on wooden timbers. For the battery-house, on Front street, near the steam generating station the length is 126 ft. 5 in., and the width 67 ft. 6 in. outside. Like the other house this one has a monitor with side windows running along the center of its roof in the direction of greater length. From tile floor to the lowest point of roof timbers the height is 18 ft. In its interior the house is divided into three bays by two rows of wooden posts that support the roof timbers, and there are two rows of battery cells in each aisle. Five rows contain 45 cells each, and the sixth row 48 cells, all of the 273 cells being connected in series to feed the railway lines.

On Yonge street the new battery-house measures 101 ft. 9 in. in greatest length, and 67 ft. wide, outside, exclusive of the boiler-room. The six battery rows contain 276 cells in all. In each house there are three six-inch sewers between the six rows of cells, and catch-basins connect with these sewers at intervals of 15 ft.

At the Front street generating station of the railway system some changes have been made by which a space about 80 ft. long and 64 ft. wide is devoted to the transforming and converting apparatus. On one of the longer sides of this area the 12,000-volt, three-phase oil switches and busbar compartments are located on th main floor, with the static discharge compartments underneath in the basement. (See Fig. 4.) Parallel with the row of oil switches comes that of the 15 350-k.w. air-blast transformers that step down the 12,000-volt current for the rotary converters that feed the railway at about 575 volts. The motor-driven blowers for these transformers are in the basement beneath. In another parallel row, distant about 9 ft. from the transformers, are the five 1,000-k.w. rotary converters, and beyond these is the switchboard, with connections to the railway and battery feeders. At one end of this board sets a motor-driven booster for the railway feeders.

The new railway sub-station on Yonge street (Fig. 2) is a nearly rectangular building, 53 ft. 8½ in. wide, and 90 ft. 11¾ in. long, both dimensions taken inside. In height above the ground outside the sub-station measures about 34 ft. to the edge of the roof, and the height inside from the main floor to the lowest cords of the roof trusses is also 34 ft. Beneath the main floor is a basement with a height of 9 ft. 6 in. The construction of this building is fireproof to a high degree, the walls being of brick, reinforced with steel columns, the floor of concrete on steel beams, and the roof of tile supported by steel I-bars and trusses and covered with tar and gravel. A 15-ton crane sweeps almost the entire area of the station inside. The main floor is designed to carry five 1,000 k, w. rotary converters and 15 350-k. w. transformers, which are connected in groups of three for serving the rotaries.

It may be noted that the capacity for 5,000 k. w. in rotary converters at this sub-station is the same as that at the sub-station on Front street, so that the ultimate capacity of equipment at these two sub-stations will reach 10,000 k. w. exclusive of the booster sets.

The transformers and converters at the Yonge street sub-station are arranged in two parallel rows in the central portion of the main floor.

On the longer side of the sub-station next to the transformers is the row of 12,000-volt, three-phase oil switches, and beneath these in the basement are the compartments with busbars of equal voltage. Along the opposite side of the station is the switchboard for railway feeders, which receive current from the rotary converters at about 575 volts. Space at one end of this switchboard is provided for a motor-driven booster. Each group of transformers is provided with a reactance. Beneath the row of transformers there is an air-tight chamber, 13 ft. wide, in the basement, and an air pressure for the transformers is maintained in this space by a motor-driven blower near one end.

The transformers, motors, converters and turbine generators above named are being supplied by the Canadian General Electric Company.

PAPER INSULATED CABLES.

In the course of a paper entitled "Data Relating to Electric Conductors and Cables," read by Mr. H. W. Fisher before the American Institute of Electrical Engineers at their recent general meeting at Asheville, it was stated that with paper cables the variation of capacity with change of temperature was generally the greater the less viscous the compound. With a certain oil insulating compound the capacity would be expressed by the empirical equation $C = 1.384 + (T - 32)^{1.59}$, in which C is microfarads per mile and T is the temperature in degrees Fahrenheit. Oily compounds were the best because the cables were readiest handled in cold weather and offered the highest resistance. Hence, the old idea of demanding high insulation resistance in megohms per mile, which was best obtained by the use of hard compounds, was incorrect, and the better informed engineers of to-day either did not mention insulation resistance at all or else specified 25 to 100 megohms per mile, depending upon the size of the conductor and thickness of insulation. The accompanying table gives the thickness of paper recommended for different working pressures and different half-hour test pressures. In presenting this table the writer wished it to be clearly understood that there was a large margin of safety in the figures given. For three-phase cables the table gives the thickness of paper between conductors.

Thickness of insulation. Inches.	Working pressure. Volts.	Factory test, 5 min. Volts.	Inst'l'd test, ½hr. Volts.
4/32 to 5/32....	1,000 to 1,900....	7,000....	4,000
5/32 to 6/32....	1,900 to 2,250....	10,000....	6,000
6/32 to 7/32....	3,800 to 5,000....	13,000....	8,000
7/32 to 8/32 ...	3,800 to 5,000....	16,000....	10,000
8/32 to 10/32....	5,000 to 6,500....	19,000....	12,000
9/32 to 11/32....	6,500 to 8,000....	22,000....	14,000
10/32 to 12/32....	8,000 to 9,500....	25,000....	16,000
11/32 to 13/32....	9,500 to 11,000....	28,000....	18,500
12/32 to 14/32....	11,000 to 13,000....	31,000....	21,000
13/32 to 15/32....	13,000 to 15,000....	34,000....	23,500
14/32 to 16/32....	15,000 to 17,000....	37,000....	26,000
15/32 to 17/32....	17,000 to 19,000....	40,000....	28,500
16/32 to 18/32....	19,000 to 21,000....	43,000....	31,000
17/32 to 19/32....	21,000 to 23,000....	46,000....	33,500

NEW OFFICES.

Allis-Chalmers-Bullock, Limited, have made a change in their British Columbia branch. This end of their business has been in charge of the local agency of the Canadian Fairbanks Company. Recently, however, Mr. G. C. Hinton, of the Hinton Electric Company, was appointed sales manager for British Columbia. They have opened up offices on the Seymour street side of the "Old Safe Block," corner of Hastings street, Vancouver. Here a complete stock of the Allis-Chalmers-Bullock products will be kept, including rock drills and rock drill parts and electric and saw mill machinery.

Mr. Hinton, though becoming local manager of Allis-Chalmers-Bullock, still retains an interest in the Hinton Electric Company.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. NO. 1.—Can you supply me with a list of companies whose pole lines are built of Portland cement? If you are not in a position to do so, can you tell me where I can get this information?

ANS.—So far as we have been able to ascertain, there are no pole lines built entirely of concrete, either in Canada or the United States. It is quite possible that in various places, concrete poles have been erected for either special or experimental purposes, but no records are available. At the Port Dalhousie end of the Welland Canal, a number of concrete poles of moderate height have been set in place, and these have been so satisfactory that seventy and eighty foot poles are now about to be built, and one one hundred and seventy foot pole is under consideration. These poles are built of reinforced concrete, and are the invention of Mr. J. L. Weller, Superintending Engineer of the Welland Canal. A company has been formed to build the poles, and will no doubt be glad to furnish you with any desired information. Address the Concrete Pole Company, Limited, St. Catharines, Ont.

QUES. NO 2.—What is the highest point of heat which a motor or generator will safely stand, when working continuously?

ANS.—The report of the Committee on Standardization of the American Institute of Electrical Engineers calls for the following maximum temperature rises, when taken by thermometer:—

Commutator, collector rings, and brushes	55° C.
Bearings, windings, iron, etc.,	40° C.

These are rises in degrees Centigrade, above the air in which the apparatus is being run, and the temperature of the air is supposed to be 25°C. If the temperature of the air be lower than that specified, then the observed rise in the machine temperature must be increased 1/2% for each degree that the air is lower than 25°C., and if the air be higher than 25, then the observed rise must be decreased in the same way. For instance, if the air were 30°C. and the highest temperature of the armature were 68 C., this would give an observed rise of 38. However, as the room temperature is 5° high, the observed rise must be decreased 2-1/2%, giving a corrected rise of 37.05°C. The above gives the method of ascertaining whether or not the maker's guarantee has been lived up to. Unless a machine be built to stand a specially high temperature, we would say that 75°C. is the highest temperature to which any standard winding should be run. Of course, some insulations will stand a higher temperature than this, but on the other hand, other will deteriorate rapidly when even a lower point is reached.

QUES. NO. 3.—How do you figure the horse power of a motor on a three phase circuit, also a two phase circuit?

ANS.—In the three phase machine, read the current in each wire. Take the average of these three readings, and multiply it by 1.73. Multiply the product by the volts, and this will give you the apparent watts input. In the two phase motor, read the current in both phases, add them together, and multiply by the voltage. This will also give the apparent watts input. From the manufacturer of the machine you can obtain curves showing the efficiency and power factor for various loads. Multiply the apparent watts input by the proper power factor, and this gives you the real watts input. Multiply this by the proper efficiency, and the product is the net watts output, which divided by 746, gives the brake horse power output. If you have an indicating wattmeter, and will advise us of the fact, we will be glad to instruct you how the connections should be made for reading horsepower with this instrument.

QUES. NO. 4.—Four large water wheels discharge into the one tail race, and at full gate opening the water raises one foot. Is this foot of "back water" equal to one foot less head or more?

ANS.—The head under which a turbine is working is the vertical distance from the head water to the tail water. Suppose you have a head of thirty feet when no water whatever is being used, and that the tail water raises one foot when the gates are open full. This means that the vertical distance between the head and tail water has been reduced exactly one foot, and that the head really becomes twenty-nine feet. In all probability the head water will drop slightly, depending upon the size of the head race. If it drop six inches, then this six inches must also come off the head, leaving an actual head of twenty-eight feet six inches when the gate is open full.

QUES. NO. 5.—What do the makers of water wheels mean by the statement:—"There is no serious objection to submerging our large turbines in tail water, as they will not clog"?

ANS.—Where a very low head is used, it is necessary to set the wheels a certain distance below the level of the head water, and this often means that the turbine is below the level of the tailrace water, or is "submerged". With a low head, a big wheel is necessary for even a small amount of power, and this means that a large volume of water must be used. The error that is usually made in the setting of turbines under such conditions, is that the tail race is built too small, and therefore, when the gates are well open, the tail race water backs up, and seriously reduces the power of the wheel. We would presume that this is what is referred to as "clogging". It is not the fault of the wheel, but of the tail race construction. A backing up of one foot on a thirty foot head is not a very serious matter, as it reduces the power of the wheels only about 5%, but on a three foot head, a foot of backing up would reduce the power about 45%.

QUES. NO. 6.—If a single transformer be connected on the secondary side to a three-wire system, would there be any discrepancy in the voltage if the load were considerably unbalanced?

ANS.—If a transformer having a regulation of 1½% be connected to a primary line on which the voltage is kept constant, the secondary voltage will be 1½% lower at full load than at no load. If the transformer be built for three wire service (all are not really suitable for such work), and one half of the secondary be loaded full, then we would expect that the voltage across this side would drop in proportion to the regulation of the whole transformer, but this is not quite the case. The drop would probably be nearer to 2% than 1½%. This, however, would be a very satisfactory regulation, and as it is extremely doubtful that in actual service one side of a transformer would be fully loaded when the other side was light, except in the case of a blown fuse, the matter is far from being serious. If we loaded the transformer the way you mention, and got a drop of 2% on the loaded side, and then gradually applied load to the unloaded side, the 2% would gradually decrease to the point where the loads were equal, and both sides carried their full load, when it would be 1½%.

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About Ourselves.

In the early days, when the apron string played the title role of guide, philosopher, and friend, we were taught of the man who had never looked upon himself in a mirror, said man being held up before our youthful eyes as an example of the modesty which was altogether fit, and which really should be found in all members of well regulated families. Being of a somewhat precocious nature, we viewed this story as a species of myth, and may have been bold enough even to hint at its appalling lack of verisimilitude. However, rather than enter into an argument which was likely to end disastrously, we accepted the legend, and stored it away for future reference. Arriving at maturity, we appreciated the yarn at its true value, but realized that it was a yarn pure and simple, fulfilling every definition of the word "myth". Others of our childhood stories deserve similar classification, but so far as concerns the one under consideration, we would quote the words of one of our great writers, who said "He who is without conceit is without ambition", or words to that effect. This, in our opinion, precludes the possibility of the truly modest man ever amounting to anything—the looking glass, while sometimes producing bad results, is not without its good points. We started out to say something about ourselves, and the foregoing is intended as a kind of explanation, and not in any sense an apology. Last month we published in our "Questions and Answers Department" a letter from one of our readers, pertaining to the Montreal Convention of the Canadian Electrical Association, and with this letter we gave our reply, and also the remarks made by this reader to one of our representatives at the convention. Since that time we have received a number of letters, complimenting us on our action, and saying that our remarks on the value of co-operation exactly suited the case. Then, too, there were other letters regretting that we had not published the communication with its answer in the previous issue, as there was a possibility of producing a still better attendance at Montreal. Personally, we would have liked to have placed the matter in the columns of our June number, but for previously stated reasons, this was impossible. The editorial sanctum of every paper is usually pictured as a strongly guarded place, to which there is no approach. This, really, is very far from being the case—we are always glad to hear from our friends, as this gives us the opportunity of glancing in our editorial mirror. In the present instance we feel quite pleased, for we always like to know how we appear to outside eyes. If space would permit, we would publish some of the letters which recently came to us, but this being impossible, we take the present opportunity of thanking the writers for their kindness, and expressing the desire of hearing from them further.

Painting of Iron.

The effective protection of exposed iron and steel structures from the action of the elements has afforded our chemists much study in recent years. This problem is a serious one, and while it is less difficult in our inland towns and cities, still on the sea coasts the action of the salt-laden air makes necessary the adoption of very different tactics. The painting of clean steel surfaces has to a certain extent been satisfactory, but only so when the paint has been renewed at closely occurring intervals. The terminal station of the Pennsylvania Railroad at Jersey City has been the scene of a series of experiments which have extended over a period of ten years, and the result of these experiments is summed up in the statement that no paint would last over eight months. In a structure of this size, the continual repainting was a very serious matter, amounting to something over $5,000 per year, and all the paints tried showed a tendency to peel off very shortly after application. The conditions at this station are, of course, extremely severe, and apparently there was nothing to do but repaint the entire structure every eight months. However, some engineer hit upon a very novel plan to keep the paint from scaling, and so far the results have been entirely satisfactory. The steel is first cleaned in the ordinary manner, and then upon the fresh surface is placed a coating of a sticky substance, which we understand is primarily a combination of boiled linseed oil and litharge, to which is added a few other substances. Over this sticky surface is pasted ordinary paraffine paper, the paper being cut so as to entirely cover the steel and fit into and over all irregularities. This paraffine paper is then painted any desired color, with an ordinary weatherproof paint, and apparently there is no appreciable scaling. If this method of protection prove to be satisfactory, it will certainly make a great change in existing conditions, and it may simplify one of the serious problems which has long confronted our civil engineers.

Mercury-arc Rectifiers. A number of our large manufacturing companies have recently placed on the market small mercury-arc rectifiers, which may be used for numerous purposes, and as this country is essentially an alternating current one, the commercial use of this machine should soon become an important branch of the electrical business. Where alternating current only is available, and direct current is required in small quantities, the rotary converter is practically out of the question, and the motor-generator set does not deserve a much higher position. Its first cost is high, and its efficiency low, and besides, things can be done to it by the untutored hand which may have unsatisfactory results. The great points in favor of the mercury-arc rectifier are its efficiency and simplicity. Re this latter item, you close your switches when you wish it to operate, and when finished, you open them again. The principle of operation of this device is extremely simple, and as information along this line may be of assistance, we desire to run over roughly its salient features. In the first place, the rectifier, in its simplest form, consists of a glass vessel from which the air has been exhausted, and which contains mercury vapor, and in which are two electrodes. The resistance of the rectifier is of a very curious nature, for when the apparatus is not in use, anywhere from 15,000 to 25,000 volts is needed to overcome the resistance between the surface of the negative electrode and the mercury vapor, while that required by the vapor itself, and between the vapor and the positive electrode, is very low, being in each case from four volts upward, depending upon the design of the rectifier. However, when current starts to flow, the resistance between the negative electrode and the vapor drops to approximately that of the vapor itself. Thus it will be seen that an exceedingly high potential is necessary to start the converter, but that once after it is in operation, a very low pressure will maintain the arc. When used on direct current, once the arc is established it will be held continually, but with alternating current, the polarity of the electrodes change with every alternation, and while the point of no current may cover but the fractional part of a second, still the interval is sufficient for the extremely high resistance of the negative electrode (whichever it happens to be) to exert itself, and the rectifier has to be restarted. From the above it will be seen that if we can make the resistance between one of the electrodes and the mercury vapor permanently low, then when this electrode is negative, current will flow through the converter from the positive, but when the next alternation occurs, the other electrode will be negative, and the extremely high resistance will prevent any flow of current. When alternating current is applied to the terminals of the apparatus, it will be seen that the current can flow in but one direction only, and while it is an alternating electro-motive-force which is applied, still the current in the circuit is a direct current, of a pulsating nature. In the single phase rectifier some means must be obtained to keep the resistance of one of the electrodes permanently low. In the type just described, another terminal must be inserted in the rectifier, close to the one whose resistance it is desired to keep low. These two terminals will be placed at the bottom of the converter, so that the mercury in the bulb can be made to bridge across them. To these two terminals a direct current of low potential is applied and the converter is tilted so that the mercury makes a short circuit. When this short is broken, by again tilting the apparatus, an arc is established and held, and then the alternating current may flow from the other main terminal to the one made negative and whose high resistance has been broken down and is held down by the direct current. In this type, it is necessary to have the direct current applied at all times. In another type, the converter is supplied with three main terminals and a starting terminal. Two of the mains are connected to the outside points of an auto-transformer, and the other to the middle point. In this middle lead is placed an inductance coil. The converter is started by tilting, as in the previous case, and once the arc is established, and the high resistance of the middle terminal broken down, then current may flow first from one outside terminal to the middle, and then from the other. The inductance coil in the middle lead makes the current in this lead lag a little behind the impressed voltage, and therefore when the voltage reaches the zero point, the inductance coil keeps the current flowing for an instant, and long enough for a current to start from the other outside terminal. Thus the converter is self-sustaining after it has once been started, and the direct current is needed only for the initial breaking down of the high resistance of the middle point. Once the rectifier is running, the direct current circuit, which may be supplied from batteries, is opened, and the arc maintains itself.

Surveys are being made for the extension of the Peterboro Radial Railway Company's system from Peterboro to Young's Point, a distance of about 14 miles. Mr. William C. Heathcote is the engineer in charge.

TRANSFORMERS*

By R. T. MacKeen.

After accepting the courteous invitation of your Paper Committee to present at the Convention an address upon some topic of interest to your Members at large, it occurred to me that a general discussion upon the characteristics of lighting and power transformers as used for pole suspension in sizes limited to 50 Kw. and less, would be profitable.

To-day, owing to the almost phenomenal growth of alternating current plants through our extensive country, the transformer occupies a field at once unique and of great importance. This piece of apparatus is familiar, in a general way, to all, and has doubtless been the object of much consideration on the part of many of our members directly interested in the production and distribution of electrical energy for both lighting and power.

It is not my purpose to go into any lengthy theoretical discussion of the principles of design, construction and operation, but rather to discuss very generally interesting points of these various features.

The principles of the transformer were exemplified by Faraday in 1831 and later these principles were utilized in developing a commercial piece of apparatus by Ferranti Mordey and many others.

In this country, the honour of first demonstrating the utility of the transformer for the transformation of high potentials to low potentials, and thus rendering practicable the use of high potentials for transmitting energy over distances greatly in excess of those possible with direct current, has been universally accorded Mr. William Stanley. In 1885 Mr. Stanley built his first commercial transformer. This transformer, which is of 1 Kw. capacity, was used during the year 1885-6 with others of similar size for the distribution of energy for lighting in Great Barrington, Mass. The construction is of the shell type, with long coils, arranged concentrically, the primary being the topmost coil.

The early commercial transformers were all of the shell type, it being generally considered that this type embodied the most economic proportions of iron and copper. Up to the year 1896 the shell type practically held the field, but this year witnessed the devefopment of the core type transformer, and since that date both types have been greatly improved in their construction and characteristics, until to-day the claims of each are emphatically pressed upon a patient public by the individual manufacturers of each type.

The usual distinction between the two types may be summarized as follows:

In the shell type, the magnetic circuit consists of two distinct paths, obtained by surrounding the coils at some portion of their surface completely, with sheet steel punchings.

In the core type there exists but one magnetic circuit common to the windings, whether single or multiple.

Many arguments are advanced by the advocates of both types, in support of their particular design. Such considerations of design as—relative coil and core radiation of heat produced by losses incident to operation; regulation as a result of the relative position of coils; the most economical proportioning of iron and copper with respect to total losses and weight; and the most efficient use of insulating materials, are arguments which are called into requisition by advocates of the two types.

About the year 1896, the advantages of the insulating and cooling qualities of oil were discovered, and transformers were first developed for the use of oil. At first it was optional with many makers whether or not oil should be used, and it is interesting to note that manufacturers at that time frequently furnished two distinct ratings for transformers; one with and the other without oil. In all cases, the containing tanks were designed so that oil could be used if desired, both for old and new types.

The use of the air cooled transformer was continued until comparatively recent years, but the superiority of the oil cooled and insulated type has resulted in the entire elimination of the air cooled type. The advantages of the use of oil may be summed up as follows: Oil preserves the insulating fabrics by keeping them soft and pliable and by excluding moisture and air. It materially assists in preventing breakdown of insulation due to minute puncturing by momentary excessive potentials.

The properties of the fluid oil in transmitting heat by convection assists in materially reducing the temperature of the parts; thus preventing the deterioration of the insulation and also enabling the size and weight of a given capacity of transformers to be greatly reduced, over the same capacity in the air cooled type.

As a direct result of competition among manufacturers, investigators early began to study scientifically the characteristics of materials entering into the construction of transformers for the purpose of improving their product, as regards efficiency of transformation, economic disposition of materials, and character of insulation.

The losses in transformers received the greatest attention. It was not long before the magnetic characteristics of iron were investigated, with the result that core losses were reduced to a minimum in leaps and bounds.

In Fig. 1, is given in the form of curves, an interesting graphic representation of the reduction in core losses, from the year 1889 to 1905. This reduction amounts in many cases to as much as 75 p. c. The average core loss per Kilowatt in sizes up to 2,500 watts in 1889 was 163 watts and in 1906 was 28 watts, a reduction of about 80 p. c. When it is considered that the core loss of a transformer represents a constant consumption of energy for 8,760 hours per year, in plants operating 24 hours per day, the importance of this improvement appeals very forcibly.

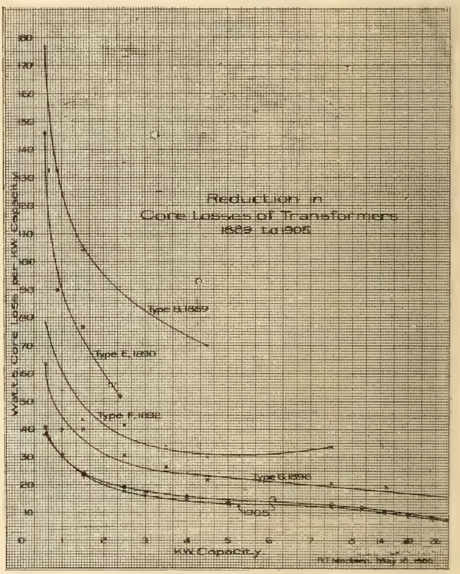

Fig. 1.

The top curve of the 1905 transformers is plotted from the average core losses, and the lower curve from the minimum core losses of transformers of both shell and core types, the products of six different manufacturers. It is here interesting to note how closely the minimum core losses approach in value the average core losses. To-day manufacturers still hope for further reduction in Core Losses obtainable through two principal sources. First, by further investigation into the magnetic characteristics of steel, and improved methods of treatment, and, second, by a better arrangement and proportioning of the magnetic circuits.

Some idea of the study given to the characteristics of iron and care exercised in its treatment may be formed, when it is known that large manufacturers equip and maintain laboratories with a competent staff of chemists and metallurgists for the express purpose of studying the structure and resulting physical and magnetic characteristics of steel composed of many different percentages of carbon and iron and subjected to many varied processes of forging and annealing. The art of microscopic metallography has been developed and applied most extensively in these investigations. This art involves the study of highly polished sections of sample rods of steel by means of a microscope. These surfaces are magnified about 200 diameters, and by treating them with certain acids which attack as solvents, the different structural compounds at different rates or different degrees, the proportions and disposition of these components can be definitely ascertained.

It is also found that this proportion and disposition of the various components bears a definite relation to its physical and magnetic properties.

The phenomena of aging of iron is also successfully studied in a similar manner.

The physical properties of steel depend upon (a) ultim-

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[*] Paper read at the 15th Annual Convention of the Canadian Electrical Association.

ate chemical composition, (b) the mechanical work, such as rolling, hammering, cold rolling, etc., which has been done upon it, (c) the heat treatment which it has undergone, i.e. the temperature to which it has been heated, the time of maintenance of these temperatures, and the rate of cooling, etc.

The magnetic properties of steel are governed by the same factors which determine its physical properties of strength, hardness, etc., but magnetically, steel seems to be more sensitive, especially to the influence of heat treatment. It is obvious, therefore, that the effect of composition and treatment becomes a more complicated problem when considered in reference to magnetic properties than in reference to physical properties. One can, therefore, appreciate the value of such a method as outlined for accurate research in the direction of producing and treating steel so that minimum core losses and aging may be obtainable in commercial transformers.

The economical disposition of materials is a subject which has received much consideration by different designers. It may be said in this connection that irrespective of whether transformers are of the core or shell type, the product of to-day represents a vast improvement in this direction over that of a few years ago. This is evidenced largely by the great reduction in weights of transformers during the last few years. Reductions varying from ten to twenty per cent. have not been uncommon. In 1896 the average weight per kilowatt was 108 pounds, and in 1905 the average of six manufacturers is 76.5 pounds, a reduction of approximately 30 p. c.

The characteristics of the insulating materials used in transformers have not, perhaps, received the amount of attention that this important phase of design and construction merits. Probably in no other field has so little investigation taken place excepting, possibly, by some of the larger manufacturers who, actuated by their own necessities, have made some considerable progress in this direction. Unfortunately, however, such results as are reached are not available to the profession in general, hence many inferior insulations are used on transformers on the market to-day.

The importance of good insulation in a transforming device is self-evident.

The comparative value of various insulations may be obtained from a study of the curves in Fig. 2., plotted from the results of tests upon the dielectric strengths of the most common insulating materials. These curves are taken from Warner & Hobart's treatise on insulating materials. The conditions under which these tests were made were not sufficiently defined to enable conclusive comparisons to be made with more recent tests upon the same materials, but they are useful in giving an idea of the comparative dielectric strengths of the different materials.

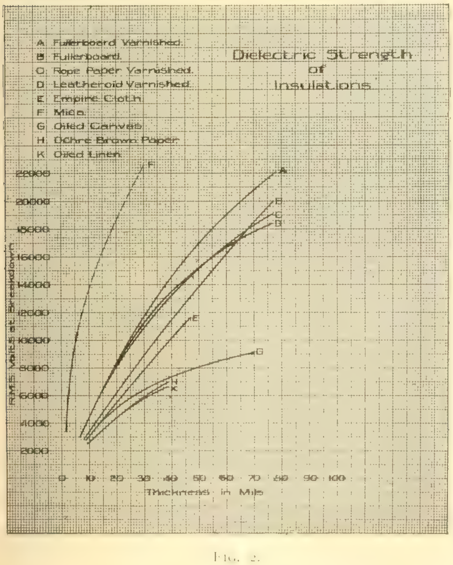

FIG. 2.

Probably the greatest problem which the designer has to solve is that of producing a design of core and coils which will admit of the proper application of the best insulating materials. For example, mica is probably one of the best insulating materials obtainable, yet due to its brittleness it is difficult except on approximately round surfaces to apply it without breaking. This is a distinct feature of core type transformers where mica insulations can be inserted between the high and low potential surfaces and windings.

The use of insulating fabrics which are more or less hygroscopic, or possess water absorbing qualities, is almost universal, simply because fabrics or materials are not obtainable to take their place. Moisture is the bug-bear of most transformer manufacturers. To overcome the entrance of moisture to the windings and their insulating fabrics and to remove such moisture as has been absorbed during manufacture, several methods have been devised. The most successful is that of removing the moisture by the application of heat at low barometric pressures, and then forcing into the windings under considerable pressure an insulating compound which thocoughly permeates the windings and renders them impervious to the entrance of moisture. It is here interesting to note that such treated insulations are rendered less susceptible to deterioration by heat.

In Fig. 3 curves are plotted, illustrating the effects of heat upon treated and untreated insulations. These curves, illustrate the results of insulation measurements between primary and secondary coils of a transformer, and clearly show the value of the compound treatment for removing and excluding moisture from the insulating fabrics.

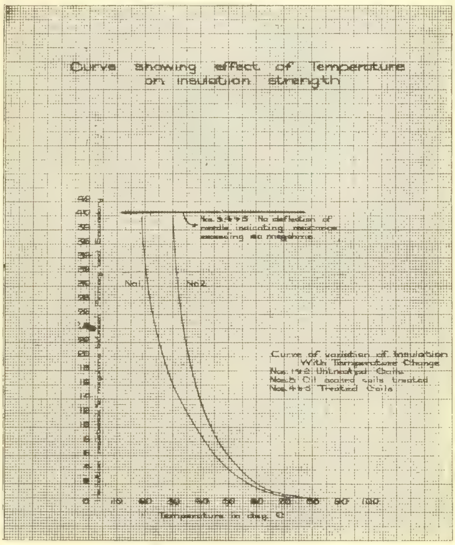

FIG. 3.

The coils of transformers Nos. 1 and 2 were wound with cotton covered wire, shellaced and immersed in oil, No. 3 was a transformer similar to Nos. 1 and 2, but had been treated, after being in use in oil about one year without treatment. Nos. 4. and 5. were treated before immersion in oil. Careful tests have shown that coils insulated by varnish and immersed in oil will readily withstand a dielectric test of 10,000 volts applied for 30 seconds between coils and core when cold, but when the temperature of these coils is increased 50 or 100 degrees centigrade a potential of 8,000 volts applied for thirty seconds almost invariably causes a breakdown of the insulation.

The particular value of the curves plotted in Fig. 3. is to illustrate the improvement in the insulation resistance of windings due to the removal of moisture and the filling of the interstices between insulations with a solid compound of high dielectric strength.

While it is true, as clearly pointed out by Mr. O. B. Moore, in the June issue of the Electric Club Journal, that insulation resistance measurements are not a criterion by any means, of the ability of any transformer insulation to withstand high dielectric strains due to excessive potentials, at the same time such a test as illustrated in Fig. 3, known to be made upon a transformer with insulations selected with due regard to superior dielectric strength, and, further, thoroughly impregnated with a fluid compound of high dielectrical strength is extremely useful in furnishing reliable evidence of the character of the insulation used and care exercised in excluding moisture from the windings. Such a test, in conjunction with high dielectric strength should be most conclusive.

As a direct result of competition, transformers on the market to-day are strikingly similar in characteristics, more particularly in that of core loss. With the larger number of Central Station Men the much mooted question of core loss is too often the basis upon which is judged the merits of transformers. So much is this the case that frequently the consideration of good insulation characteristics and subsequent increase in losses due to aging is completely ignored. I think it highly desirable to touch upon this phase of the transformer situation as it appears to me at the present time.

The advantages derived from the operation of transformers selected from among the many types now obtainable on the market, on a minimum core loss basis alone are not by any means as great as is ordinarily thought. While it is desirable to use transformers in all cases where plants are operated for 24 hours per day, which have small core losses, at the same time, the difference between the minimum core losses and the average core losses of the different types and makes, is not sufficient to warrant a selection on minimum core loss basis to the exclusion of other considerations of design and construction, as is frequently the case. To illustrate this point, the curves shown in Fig. 4 have been prepared. These curves are plotted from the maximum, minimum and average core loss published figures for all sizes from 6 to 50 Kw., of both shell and core type transformers, the product of six different manufacturers whose transformers are marketed in Canada to-day. The middle curve represents the average, the top curve the maximum, and the bottom curve the minimum core losses per kilowatt of transformer capacity. A surprising degree of closeness is evidenced. The maximum variation of the maximum core losses from the average losses is 15 p. c. and the minimum variation 1.4 p. c., the average of all sizes being 9.3 p. c.

The maximum variation of the minimum core losses from the average losses is 11 p. c., and the minimum variation .85 p.c., the average variation of all sizes being 5.3 p.c.

If we assume that a selection has been made on minimum core loss basis alone, it will be found that practically all the different types are represented in various sizes, and a similar statement applies to a selection based on a maximum core loss basis. On the other hand, a selection of transformers with moderate core losses will cause possibly one or two types to predominate. Such being the case, it is possible then to select such types as best embody other important characteristics such as good regulation, high insulation, moderate copper loss and moderate temperatures. In general, it will be found upon investigation that the average core losses for all sizes of transformers on lines to-day will not vary much more than two or three per cent. either way from the average figures plotted in the curve of Fig. 4. This means that transformers on the market to-day have core losses in general in quite close agreement, and when such other important characteristics as alluded to are desirable, little choice is left for a selection on a core loss basis alone. A low core loss is certainly not to be desired, at the sacrifice of low copper loss, good regulation and possible skimping of insulation.

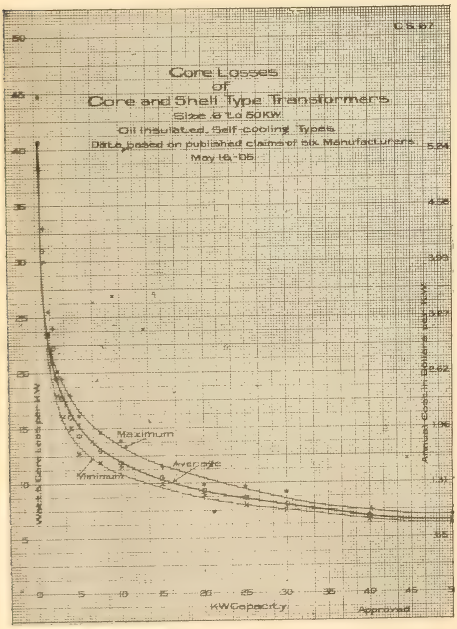

Fig. 4.

The curves furnished in Figs. 5 and 6, are interesting in graphically showing the maximum and minimum variations from a mean value of the copper losses and regulation of the same transformers as referred to in Fig. 4.

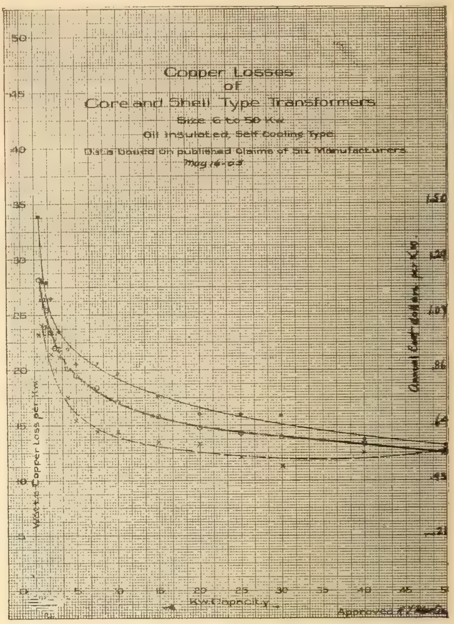

Fig. 5

Copper losses in general do not appear to carry so much weight with buyers, and yet they are quite as expensive, and in fact may be more so, than the core losses per annum, depending entirely upon the hours of service and the cost of power.

It will be found in general that transformers with moderate core losses also possess moderate copper losses and that the more prominent types agree fairly closely in characteristics so that comparatively, there is little to choose between them. From these curves it will be seen that the maximum copper loss per kilowatt for all sizes is 9.0 p. c. higher and the minimum copper losses 12 p. c. lower than the average.

In Fig. 6. curves are plotted showing the maximum average and minimum percentage regulation of the transformers under consideration. It will be noted that while in some individual sizes a wide divergence exists, yet they follow in some measure, a line of but moderate deviation.

In nearly all cases even the maximum percentage regulation is within the bounds of commercial requirements, particularly for small plants where regulation of the prime movers and generators do not receive such close attention as is possible in large centres.

Before leaving Fig. 4, it is interesting to note that the curve of core losses also clearly indicates the wisdom of utilizing as large transformer units as possible on your lines, in order to maintain the annual cost per kilowatt for core loss at a minimum figure. Available figures of yearly output in transformers by several manufacturers indicates that the greatest demand is for 5 Kw. and 15 Kw. units, which based upon the curves of average core losses, and a cost of $.015 per Kw. hr. for power would have an annual cost of $1.50 and $2.25 respectively.

Coming now to the consideration of insulation; it is clear to all that an unavoidable moral responsibility rests upon every central station manager, compelling him to place at any cost, transformers upon his poles which are as perfectly insulated as can be made possible with our present insulating materials. Manufacturers will say that their transformers comply on test with the breakdown voltages specified by the American Institute of Electrical Engineers. This may be true; but will they continue to withstand repeated high voltage strain imposed under the usual conditions of operation and temperature? Has the

Central Station Manager, and, of greater importance, his Customer, any guarantee that his transformer will meet the above specifications and may feel assured that his property and life are not endangered?

The argument that a grounded neutral will offset all danger, may be advanced. Very well, what happens if the grounded neutral is not properly and effectively grounded? Is it not far better to eliminate the weakness in the apparatus itself rather than to provide a possible means of avoiding trouble from breakdown, as a result of lack of insulation? It is well to ground the neutral in any case; at the same time there may be a tendency to utilize this means of protection to the detriment of good insulation in the apparatus initially.

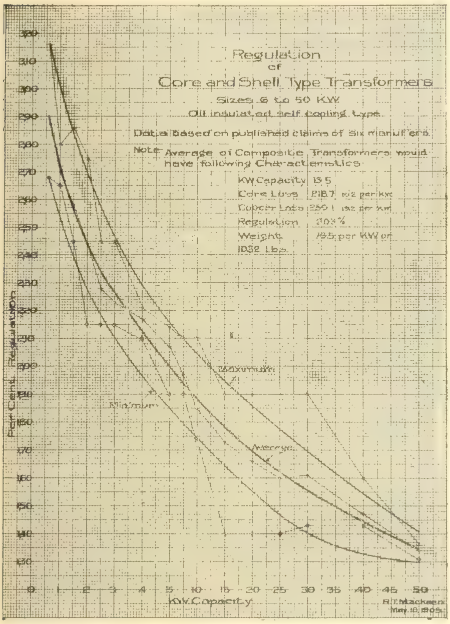

Fig. 6.

The importance of entirely separating the high and low potential windings by an insulation which will permit either winding to be completely destroyed without affecting the other coil, is obvious to all. Several manufacturers provide such insulation even at the expense of additional cost of manufacture, for which they deserve commendation.

In practice, it is oftentimes impossible to properly ground the neutral or one side of a transformer secondary at the pole, due to the character of the soil. In such cases a good plan is to make ground connections at every house by tapping the neutral of a three wire circuit or one side of a two wire circuit, just before it enters the house, and carrying the ground wire down the outside of the house and grounding to a water pipe in the basement. In grounding two wire systems in this manner, if there is more than one service supplied from the same transformer, it is obvious that care must be exercised in grounding wires of the same potential; otherwise a short circuit will ensue.

Considering now the matter of aging of transformer iron, we have to deal with a problem which, until a few years ago, was a phenomenon about which comparatively little was known.

In 1891 the fact that the energy losses in sheet iron or steel forming the core of a transformer change with the life of the transformer was first prominently brought to the attention of engineers by Mr. G. W. Partridge, in the columns of the London "Electrician". Subsequently, in December of this year, Mr. William Mordey read a paper before the Royal Society, entitled "Slow Changes in the Magnetic Permeability of Iron", giving the results of exhaustive investigations made by the author upon this phenomenon. Both prior and subsequent to this period, the larger transformer manufacturers were giving this matter their study, and although not generally known, had, as a result of their investigations, arrived at several conclusions which enabled them to cope with the problem with highly successful results.

The following conclusions have in general, been reached by individual investigators and others.

First. There is unquestionably such a phenomenon as aging.

Second. This increase in the loss in a given body of iron is dependent solely upon the temperature at which it is maintained.

Third. A great difference exists in the amount of aging taking place in different qualities of iron and steel when maintained at the same temperature.

Fourth. Within ordinary limits of temperature the tendency to age is greater the greater the temperature.

Fifth. Soft sheet steel is much less subject to aging than soft sheet iron.

Sixth. Sheet steel that does not age materially at moderate temperatures (below 75°C.) can be obtained, but almost any iron or steel ages more or less at higher temperatures.

Seventh. The real cause of aging has not been discovered. Many of the laws governing it have been determined, but there is room for further study and investigation.

Having established the fact that sheet steel can be obtained which will not age perceptibly at moderate temperatures (below 75°C.) it was evidently important that the maximum temperature of transformers be kept well below this point. It is rather an odd coincidence that the temperature of 75°C. also marks the safe limit at which it is desirable to heat our present form of insulating fabrics. These conditions, therefore, led the large manufacturers to design their transformers with very moderate temperature rise under normal conditions of operation.

It is obviously impossible to discuss the methods used by the large companies for the production of steel which is non-aging in character, as this comes under the heading of trade secrets with both the transformer and steel manufacturers. Suffice it to say that sheet steel can be produced which is practically non-aging at temperatures below 75°C.

With the large manufacturers, steel is purchased from mills of the highest standing, where it is produced to comply with strict specifications as to chemical composition and methods of manufacture. After the reception at the Factory it is still further subjected to certain treatments which further improve its magnetic characteristics and its non-aging quality. The last treatment has a far greater effect upon the final results both as to low magnetic losses and permeance than, perhaps, all the previous treatments combined. The elaborate and expensive furnaces and apparatus necessary to carry out these further processes form one of the most valuable assets of the manufacturing company.

After the final treatment the steel is tested magnetically and sample lots are reserved for long continued age tests.

The tests do not terminate with the completion of the transformer, but sample transformers are placed in ovens which are maintained at predetermined temperatures.

The curves in Fig. 7, indicate the value of such tests. After 14 weeks baking at 80°C. the transformer "H" has aged less than 4 p. c., whereas transformers "A", "D" and "C" of different manufacture had aged 41 p.c., 36 p. c. and 22 p. c. respectively.

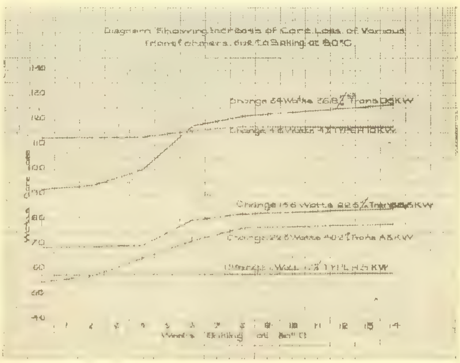

Fig. 7.

The value of the methods involved in the art of microscopic metallography as a means of studying the characteristics of steel has already been alluded to and sufficient has been said to clearly impress the reader with the great progress which has been made in bringing this comparatively unknown phenomenon within our control.

The matter of aging does not appeal so forcibly to as many of the Central Station Men as it should, when it is considered that a 10, 20, 30 and even in some cases a 100 p. c. increase in the initial core loss of a transformer due to aging occurs with inferior types of transformers, representing the same percentage increase in the annual cost of operation on a core loss basis. While it is true that in any event the sum total of the core and copper losses represents but a small percentage of the energy transformed, yet this is not an argument for a Central Station Manager to listen to, who appreciates the economies of central station operation in any degree.

More consideration should be given to this point, and the decrease in your annual expenditure for energy losses in transformers will fully justify such consideration.

In concluding this address I would strongly recommend that Central Station Managers give the subject of transformer Insulation and Aging more consideration and attach less importance to the small differences in core loss claims advanced for the various types of transformers.

BOILER MANUFACTURERS IN CONVENTION.

The Boiler Manufacturers Association of the United States and Canada held its seventeenth convention in the King Edward Hotel, Toronto, July 25th to 27th inclusive. President Robert Munroe, of Pittsburg, presided. The delegates were welcomed by Acting-Mayor Shaw and Mr. J. J. Main, Chairman of the Local Committee.

The President in his annual address, said :—" To-day the boilermaker stands at the very helm of civilization, and it is the purpose of this Association to instruct the engineer how to manage boilers, and the boilermaker how to design and build them. If we can do this the Association will have made a grand success, and will be well repaid for all the trouble it has been at since its organization. There was a time when we thought every competitor was an enemy, and ready to pounce down upon us like a hawk, but since the formation of the Association we found they were the best people that ever lived. We understand each other, and work together, progressing as we go, and in this we have even done more for the public than for ourselves."

Col. Edward D. Meier, of St. Louis, presented the report of the Committee on Uniform Boiler Inspections, reviewing several years' work at Washington. The committee is endeavoring to get a commission appointed by President Roosevelt to hear all sides and straighten out the tangle of inspection laws.

A subject discussed at some length was the chemical constituents of steel, and especially the percentage of sulphur in the boiler steel furnished by the steel makers. The boiler manufacturers claim that the present percentage of sulphur gives too little ductility for the tensile strength of the material. The steel men, on the other hand, claim that the grade of steel now furnished is satisfactory, and that a lower proportion of sulphur would make more difficult the process of manufacture without giving any practical compensating advantages. The boiler men desire a percentage of .025 sulphur, while the steel makers want the percentage at least .035.

The following resolution affecting the relations existing between the boiler makers and manufacturers of special materials was passed:

Whereas strong and repeated protests have been made at our executive sessions against the growing practice of supply houses and mills furnishing materials and partly finished product to others than boiler manufacturers, thus encouraging them to take away work which legitimately belongs to our members, therefore, be it

Resolved, that we request the supply houses and manufacturers in general to discontinue this practice, as likely to subvert the pleasant relations now existing between us.

That, as they depend on our patronage for the bulk of their business, they should instead of supplying such goods to outsiders refer them to the shops from which they receive this patronage.

And that we would prefer to have this done under a feeling of mutual goodwill and not be compelled to adopt arbitrary measures.

The election of officers resulted as follows :—R. Munroe, jr., president, Pittsburg, Pa. ; J. D. Farasey, secretary, Cleveland, O. ; Joseph Wangler, treasurer, St. Louis, Mo. ; M. F. Cole, first vice-president, Newman, Ga. ; John J. Main, 2nd vice-president, Toronto ; John Rourke, 3rd vice-president, Savannah, Ga. ; J. Don Smith, 4th vice-president, Charleston, S. C. ; G. H. Kittoe, 5th vice-president, Aurora, Ill. Pittsburg was selected as the next place of meeting.

The social features included an automobile ride to Lambton Golf Club, sail on steamer Chippewa, tally-ho ride around the city, trip to Hanlan's Point, excursion to Niagara-on-the-Lake, and banquet at King Edward Hotel.

The local committee was composed of : J. J. Main (chairman); W. P. Bull, secretary-treasurer ; Joseph Wright, W. J. Guy, A. M. Wickens and W. Inglis.

The town of Ingersoll, Ont., is taking tenders on a system of street lighting by electric light or gas or a combination of both.

Mr. Cecil B. Smith, C. E., of Toronto, has been engaged by the City Council of Winnipeg, Man., to make preliminary investigation of the various sources of power available for use in that city. It will be necessary to secure legislation from the Provincial Government to permit the city to spend money outside the municipality.

AN EPOCH IN THE TURBINE ART.

With the successful closing of recent negotiations for two 7,500 k. w. Westinghouse turbine type generating units, the New York Edison Company has inaugurated an important epoch in the history of Metropolitan electric lighting in this country by adopting generating units of such unprecedented size.

The importance of this step is enhanced by the fact that these turbine units will be installed in the finest and largest of American central stations, Waterside station No. 2, that ultimately will contain ten units of the same size. Waterside station No. 1, it will be remembered, is equipped with Westinghouse vertical three-cylinder compound reciprocating engines which, although installed only a few years ago as then representing the highest type of large engine construction, have so soon been outclassed through the rapid advance of the steam turbine system. No less than eleven of these large engine type units are now in service in this station, each rated at about 6,500 h.p. capacity and direct connected to a 3,500 k.w. generator. The next step in the acquisition of larger units resulted in the installation of 5,000 k. w. turbine units of the Curtis type.

In the equipment of the new Waterside station with Westinghouse turbine units of still greater capacity, over twice that of the original engine type units, there will here exist a striking example of the extremely rapid development in power station construction that has taken place since 1900.

The extreme compactness of the new generating unit is evidenced by the small space it requires in the new power station arrangement. Its overall dimensions are appoximately: length 50 feet, width 17 feet, height 15 feet; floor space 850 sq. ft. per unit net, or .113 sq. ft. per k.w. capacity. This is less than one-half the space occupied by the engine type units which are the most compact type yet built for central station work.

A condenser of the surface type will be located beneath the turbine in the foundations proper. This arrangement is in all respects equivalent to that claimed to be incidental only to the vertical type of turbine which requires much extra space for condenser and turbine auxiliaries.

The new turbines will operate under 175 pounds steam pressure, approximately 28 in. vacuum and 100 degrees superheat, the normal speed of the unit being 750 r. p. m. Under these conditions the economy of the complete unit will be in the neighborhood of 16 pounds per k. w. h. at full rated load.

Each unit will have an overload capacity of at least 50%, or will be capable of developing full rated load without the use of a condenser. A distinctive feature of this design is that the turbine gives its best economy around full rated load, although a large overload capacity is at all times instantly available when required without material sacrifice of efficiency. At this maximum load each turbine will be developing over 15,000 h. p. at the shaft, which is by far the greatest amount of power ever developed in a single prime mover in stationary service.

The direct connected turbo-generators will be of standard Westinghouse construction delivering 6,600 volt, three-phase current to the high tension network at a frequency of 25 cycles per second. The generators will embody the new enclosed construction which constitutes an important advantage in the entire elimination of the hum peculiar to high speed turbine generators. They will have an efficiency approximating 97½% at full rated load. Each generator will be able to sustain for several hours an overload of 50% within reasonable temperature rise.

It is of interest in connection with this important installation that almost simultaneously three Westinghouse turbine units of the same size have been adopted by two large Brooklyn power stations, one for railway and the other for lighting service, making a total of over 50,000 h. p. in turbine machinery of this size. Two units will go to the Brooklyn Heights Railway Company and the third to the Brooklyn Edison Company.

BRITANNIA MINES ELECTRICAL EQUIPMENT.

The electrical power plant of the Britannia Mines on the Howe Sound, some few miles north of Vancouver, B.C., has been completed and is now in operation. The motive power is derived from two huge Pelton water wheels. The water to turn these wheels is supplied from Britannia Creek. The head of water used is one of the highest on the Pacific Coast. The hydraulic pressure on the pipe lines just back of the wheels, with the nozzle open, shows an effective pressure on the water wheels of 803 pounds per inch on a head of 1,750 feet. The water from the brow of the hill is brought down in steel pipes, tested under hydraulic pressure to 1800 pounds per inch. The pipe line is 2⅝ miles long, the first mile being of wooden stave pipe, there being very little grade. The remaining 1⅝ miles consists of the steel pipe above mentioned, the most of the drop being in this stretch of piping.

The transmission lines and the wiring were installed by the Hinton Electric Company. The machinery and pipe installation was under the direct supervision of Mr. Wynn Meredith.

The Jones & Moore Electric Company, of Toronto, are making arrangements to establish a branch in Winnipeg.

A proposition to develop a water power on the White Mud river is now being considered by the municipality of Neepawa, Man. Engineer Archibald has submitted a plan of the proposed work, which he estimates would cost $40,000 and produce 400 horse power.

OPERATION OF ALTERNATORS IN PARALLEL[*]

By A. L. Mudge.

The operation of alternating-current generators in parallel is a condition which exists in practically every power house of any size using A. C. apparatus. It is a condition which has such an important bearing on the design and construction of so many power houses, that a short time spent in considering some of the questions involved may be profitable. Pardon me, if I tell you a good many things that you already know, but the subject is one that has been very thoroughly thrashed over, and most of the problems in connection with it have already been successfully solved, so that I have no brilliant discovery to lay before you. I will simply take up with you some of the advantages secured by parallel operation; the requirements therefor on the part of the generators and prime movers, and then consider a little more fully some of the points which come up in practical operation.

First of all, why do we want to run alternators in parallel at all? In the earlier stations there were, perhaps, two or three alternators, each carrying several single-phase lighting circuits. The generators were not operated in parallel, and when at certain times of the day the load was light, it was found that perhaps three machines were all running very inefficiently at light loads, whereas, if all the load could be transferred to one machine, that machine would be fully loaded and operating at good economy, while the two remaining units could be shut down. The next step was to put in a system of double throw switches, so that the load could be transferred from one generator to another, and so operate the plant at all times at fairly high economy. This worked pretty well as long as the load consisted of lamps only, and the customer did not kick at the wink in his lights three or four times during the evening, when his circuit was thrown onto another machine, or at the fluctuations in voltage which occurred when a sudden load was thrown onto a small, poorly-regulating alternator, which was driven by an engine, which, perhaps, was also regulated rather poorly. Polyphase machines were installed and motor load taken on. The bugbear of low-power factor made itself apparent. The disadvantages of operating different circuits from separate alternators became more pronounced than ever. Synchronous motors could not readily be transferred from one alternator to another. Parallel running was adopted, aad although it introduced some new problems, it solved many of the old ones. It simplified the switchboard and station wiring; it improved the service and made it more reliable by doing away with the necessity of frequently transferring the circuits from one generator to another, and by this means prevented many interruptions, however slight, to the service. Additional generators could not be put into or taken out of service without the knowledge of the customer. I remember a good example of this. Some 2,000-k.w., 2,300-volt generators were being operated in parallel, two or three years ago, in a water-power station, when a coil in one of the generators short-circuited. The damaged generator was kept in service carrying its load four or five minutes after the short circuit was noticed, while another generator was started up from rest and thrown in on the bus bars. During this time, the copper was white hot in the coil at point of short circuit. Even the sub-station at the other end of the line was not aware that anything unusual had happened. It would probably be impossible to do this with a generator wound for a voltage much above 2,300 volts, as a ground would take place to the frame of generator, which would probably throw the machine entirely out of business at once.

The whole plant can be operated more economically, the voltage regulation is better. For example, it an induction motor, say of 200 h.p. rated capacity, is started up under full load, from a 600-k.w. generator (perhaps in some cases it would not be started very easily), I think you know the severe effect which would be produced upon the voltage; whereas, if the same motor were started up from a line supplied by power, say from four or five 600-k.w. generators, operating in parallel, the voltage fluctuation would be slight compared to what it was in the first case.

In the days when many circuits left the power house for local distribution, it was possible for each generator in the station to carry several of these circuits. But, with modern power houses, many of which contain a dozen or more generators, and possibly only two or three outgoing high-tension circuits for a long-distance transmission, there is nothing to do but operate the generators in parallel, as the cost of running a separate high-tension circuit of many miles in length for each generator would be prohibitive.

REQUIREMENTS OF GENERATORS

One of the highest authorities upon the design and operation of alternating-current generators says: "The problem of parallel operation of alternators is almost entirely a problem of the regulation of their prime movers, especially steam engines, but no electrical problem at all." This is very true, but at the same time there are certain requirements as regards the generators, which, if they are met, will make their parallel operation more satisfactory.

The machines should have practically the same wave form. This is not a point that requires very much attention on the part of the purchaser, or the operating engineer, as all good modern commercial alternators have wave forms that approach a sine wave very closely.

They must have the same frequency, the same terminal voltage, and they must be in synchronism—i.e. to say, the instantaneous value and direction of the E.M.F.'s of both machines must be alike at all times for perfectly satisfactory parallel operation. The generators may operate in parallel more or less successfully, even though these requirements are not all perfectly met, but the more nearly they are met, the more satisfactory will be the parallel operation.

If the machines are to have the same frequency, they must be driven at the correct speed to produce that frequency. If they are to have the same terminal voltage, the field excitation must be properly adjusted to produce it. If the frequency and voltage are not alike, cross currents will flow between the alternators in a local circuit. If the frequency of the alternators is exactly the same, but the field excitation is such as would not give the same terminal voltage on each generator, a local current flows between the machines. This is a wattless current magnetizing the field of the machine of lower excitation and demagnetizing the field of the machine of higher excitation. This magnetizing and demagnetizing effect is such that it causes the terminal voltage of the two generators to be the same, although they are differently excited.

A simple experiment shows the above very clearly. Excite two generators to exactly the same terminal voltage and throw them in parallel. If the frequency of both generators is the same, they are perfectly in step, and no current will flow between the armatures of the two machines. Now, decrease the field excitation of one of the generators, and as you go on decreasing it you will see the armature current of both generators increasing till at length both generators may be carrying full load in amperes, although there is no external load on them. This current is entirely wattless, except for the small C R losses produced in the armatures of the generators, and it will take no more power to drive the generators (although they are carrying full K.V.A. load) than it would take to drive them when the ammeter needles are at zero. In fact, if the regulation of the machines is poor, you can pull the field current entirely off one machine and over excite the other; then the two will have a fairly high terminal voltage, the machine, which is entirely without field excitation, being excited by the wattless currents in the armature circuit.

Cross currents will also result if there is any tendency towards inequality of frequency. As long as the machines stay in step, the frequency must be the same, but, if the driving power of the generators is such that one machine pulls slightly ahead of the other, then cross currents flow which transfer energy from the machine which tends to run faster to the machine which tends to run slower. This really means that the machine which tends to run faster is, for the moment, a generator, and runs the machine which tends to run slower as a motor. Then, the so-called generator on account of its additional load, will now slow down in speed, while the so-called motor, as it has been relieved of its load, will begin to speed up, thus bringing the machines exactly into step again. As long as they are in the slightest degree out of step, cross currents will set up tending to bring them back. These cross currents stop immediately the machines are exactly in step again, so that you see there is a strong force ready to act to bring the machines back into step just as soon as they begin to get out of step. If you see this point clearly, it will not be hard for you to understand one of the most important conditions regarding parallel operation.

The generators should have a moderate amount of armature reaction, which might roughly be said to be represented by the inherent regulation of the generators. The smaller the armature reaction or the better the regulation the larger are the cross currents flowing between the generators, and the more is the operation of the generators disturbed by these cross currents. On the other hand, the larger the armature reaction or the worse the regulation the less is the synchronizing current that can flow between the machines to bring them back into step when they tend to fall out of step.

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[*] Paper read before the 15th Annual Convention of the Canadian Electrical Association.

A good, modern alternator will have a regulation of from six to eight per cent. from full load to no load at 100 per cent. power factor, and from 15 to 20 per cent. at 80 per cent. power factor.

The inherent regulation of the generators should be approximately the same, although generators having somewhat different regulations will operate satisfactorily in parallel if the field excitations of the different machines are properly adjusted as the load varies; otherwise wattless cross currents will flow between the generators. In adjusting the field currents of the different machines for increased or decreased load, the field current of the machine having the poorest regulation will always have to be varied through the widest limits.

The regulation of generators for satisfactory parallel operation does not have to be nearly so exactly the same as must be the regulation of transformers, which are to be paralleled upon both primary and secondary sides, because with the latter the proper division of load between the transformers depends upon the regulation, whereas the division of load between alternators depends neither upon their inherent regulation nor their terminal voltage but, as will be explained later, upon the speed regulation of their prime movers.

Heavy copper rings around the pole pieces, usually called dampers, are frequently used to assist in keeping the generators in step. As soon as the generators begin to get out of step, very heavy currents are induced in the dampers, which act as a drag opposing the tendency of the machines to get out of step.

The above remarks regarding tendency of machines to be pulled out of step, and the need of cross currents and dampers to hold them in step, have most importance with reference to machines which are driven by prime movers which have some inequality in their rate of rotation. This refers to alternators driven by either steam engines or gas engines. The requirements of the prime movers are uniform, angular rotation, and uniform drop in speed from no load to full load. The speed regulation must not be too great, as this would mean too great a change in frequency of the system under a varying load. Nor is it well for the speed regulation to be too small, or there may be difficulty in getting the two generators to share the load properly.

We will consider some of the different prime movers—first of all, with reference to the question of uniform, angular rotation.

With a steam engine, the torque and thus the speed of rotation rises and falls periodically during each revolution with the frequency of the engine impulses. The alternator connected with the engine will thus not have uniform frequency, but a frequency which rises and falls. The amount of this pulsation in the frequency depends upon the type of engine and on the momentum of the flywheel. In a single-cylinder engine this pulsation is worst. It is better in a two-cylinder cross-compound engine where the cranks are at right angles, and is still better in the Manhattan type combination horizontal and vertical engine, where there are four cranks arranged to give the most even torque possible upon the crank shaft.

You can readily see that if we parallel two generators driven by engines, one of which receives an impulse tending to make it increase in speed at the same time as the other engine tends to decrease in speed, then the generators have gone slightly out of step, and cross currents will result. It is absolutely necessary to keep these cross currents within a reasonable limit for if they are allowed to exist, they add to the K.V.A. load of the generators without doing any useful work.

In order to keep these pulsations within limits which will admit of satisfactory operation, the engines must be furnished with flywheels of sufficient momentum. The heavier the flywheel the less will be the angular variation in speed during one revolution of the engine. Most manufacturers of electrical machinery specify that for successful parallel operation there must not be an angular variation in the speed of prime mover of more than 2½ electrical degrees, either ahead or behind absolutely uniform rotation. This means that the maximum difference in phase between the two generators must not exceed five electrical degrees. Most manufacturers of electrical apparatus insert a clause reading somewhat as follows in their A.C. generator specifications:

"Operation in parallel — We guarantee successful parallel operation between our generators without 'hunting,' 'racing,' or 'pumping,' whether driven by waterwheels or steam engines, provided that the variation of the angular velocity of the prime movers does not produce between two generators operating in parallel a displacement of more than five (5) 'electrical degrees,' by an 'electrical degree' being understood the 180th part of the angle between two poles."

If the angular displacement between the two generators is not over five electrical degrees the maximum cross current is confined to a comparatively small proportion of the full load current.

Consider a 60-cycle, 48-pole alternator running at 150 r.p.m. The allowable variation from mean uniform rotation is 2½ divided by 24, or .104 of a mechanical degree. Now consider a 25-cycle, 24-pole alternator of the same k.w. capacity running at 150 r.p.m. The allowable variation from mean uniform rotation is 2½ divided by 10, or .25 of a mechanical degree. That is to say, two 25-cycle generators may be allowed nearly 2½ times as much angular speed variation as two 60-cycle generators, and yet operate in parallel just as satisfactorily. This means that less flywheel effect is required for 25-cycle generators than for 60-cycle generators at the same speed. In other words, the flywheel of a 60-cycle generator will be heavier, and, therefore, the engine will be more expensive than for a 25-cycle generator. From this you will see that for the most successful parallel operation for direct-connected alternators, low frequencies are more desirable than high frequencies, and for the same reason high speeds present less difficulties than low speeds, as far as the weight of the flywheels is concerned, for, in both cases fewer field poles are required, thus increasing the allowable angular speed variation of the engine, and, therefore, decreasing the required flywheel effect.

For any particular speed, the flywheel effect of a wheel is proportional to the weight of the wheel multiplied by its radius of gyration squared. As most of the weight of the wheel is concentrated in the rim, the centre of gyration is, therefore, located in the rim, so the radius of gyration is usually slightly less than half the outside diameter of the flywheel. If the flywheel is of the same weight but of double the diameter, the flywheel effect is about four times as great. For economy in the weight of the wheel, it is, therefore, well to have the flywheel of as large diameter as possible. The diameter of the wheel is, of course, limited by the fact that if the wheel is run above a certain peripheral speed, the mechanical strains in the iron become too high. The safe limiting peripheral speed for a cast iron wheel with solid rim is about 6,000 feet per minute. Flywheel type alternators are sometimes used, the field poles being attached directly to the rim of flywheel, which is dovetailed or drilled to receive them. They are only practicable in the larger sizes, because with small-diameter machines the flywheel would be so small that it would be impossible to get the required amount of cast iron inside the diameter of the stator to produce the necessary flywheel effect for satisfactory parallel operation; whereas, if the diameter of the machine were sufficiently increased to obtain the necessary flywheel effect in the wheel, it would result in poor electrical design, and greatly increase the cost. Instead of doing this, it would be better and cheaper to use a standard engine type generator, in which the rotor spider is simply designed to carry the field poles, and then put a separate flywheel on the shaft. This separate flywheel can, of course, be made of larger diameter than the rotor, thus obtaining the required flywheel effect, without the use of such a large amount of cast iron in the machine.

With generators belted from different engines, the flywheel effect required is not so great as if the generators were direct connected to the engines, as the belts have a certain amount of flexibility.

If generators are belted from the same shaft, which is run by an engine having considerable angular variation, the generators may be run in parallel satisfactorily as long as only lights are operated from the system, whereas, the operation of synchronous motors or rotary converters on the system might not be satisfactory. Of course, if the angular variation was enough to produce a noticeable change in voltage during each revolution, even the operation of lights might not be satisfactory.

GAS ENGINES

Very much the same remarks as regards flywheels apply to gas engines as apply to steam engines.

For the same number of cylinders they require a greater flywheel effect, as they are generally four-cycle, single-acting. That is to say, that one impulse, in a single-cylinder engine, is given only every second stroke, and the gas explodes on only one side of the piston. This means that heavier flywheels or more cylinders must be used. A recent installation consists of a 300-k.w., 25-cycle generator at 167 r.p.m., which is now being driven by a gas engine having six cylinders spaced at 60 degrees around the crank shaft. By arranging the cylinders in this way a moderate-sized flywheel could be used, and successful parallel operation ensured.

Prime movers which give a uniform torque are the most satisfactory for parallel operation, and for these no flywheel is required to secure satisfactory parallel operation, as they have an absolutely uniform angular rotation. However, a certain amount of flywheel effect may be required to prevent large fluctuations of speed which would be caused by sudden fluctuations of load on the generators. The prime movers should, of course, have suitable governors to help take care of this.

Some of the prime movers giving a uniform torque are as follows:

- Water wheels,
- Steam turbines,
- Induction motors,
- Synchronous motors,
- Direct-current motors.

With these prime movers, the question of parallel operation, as far as regards uniform angular rotation, is a simple one. It is a well known fact that water-wheel driven generators run exceptionally well in parallel.

Descriptions have recently been published regarding the very successful parallel operation of a 5,500-k.w. turbine-driven generator with the 5,008 k.w. generator run by the combined horizontal and vertical four-cylinder A. C. engines in the Interborough power house in New York. The four-cylinder engines ensure a comparatively small angular speed variation, and this accounts for the patricularly good results obtained.

DIVISION OF LOAD

The division of load between the alternators depends entirely upon the prime movers. Changing the field current does not alter the division of load as it does on direct-current machines. It simply increases the wattless current between the machines. It might be interesting to compare the way the load is divided between compound-wound, direct-current machines with the way the load is divided between alternators running in multiple. With D. C. generators the compounding on the different machines must be the same, otherwise one machine will take more than its share of the load, while with alternating-current generators running in parallel, the speed regulation of the prime movers, from no load to full load, must be the same to ensure proper division of load. If the speed regulation is not the same, the generator driven by the prime mover having the better regulation will take too large a proportion of the load. For example,—consider a water-wheel having a speed regulation of four per cent. from full load to no load driving a generator which is paralleled with a generator driven by a water-wheel having a regulation of two per cent. Supposing that the water-wheel governors are adjusted so that the no-load speed of both generators are the same, then half load on the first generator will cause two per cent. drop in speed, while full load on the second generator causes the same drop in speed. Any addition to the load would overload the second generator, while the first generator would not yet be carrying its full rated load.

Instead of adjusting the governors to run at the same speed at no load, suppose we adjust them to run at the same speed at full load, then when sufficient load has dropped off to allow them to run at two per cent. above full-load speed, the wheel having a regulation of four per cent. will be carrying all the load, and the wheel having a regulation of two per cent. will be entirely unloaded. If the load be decreased still further, the generator connected to the wheel having two per cent. speed regulation will then run as a synchronous motor. It is not well for the speed regulation to be too close.

Two alternators belted to the same shaft will operate satisfactorily in parallel, if care is taken that the pulley dimensions are such as to make the frequency of both machines exactly the same. A very slight error in the pulley dimensions will make it necessary that one belt should slip more than the other all the time, and the generator running at the higher speed will take too large a proportion of the load. Even with correct pulley dimensions, care should be taken that belt tension on both machines is about the same. If not, the machine with the tighter belt will take too much of the load.

If the generators are driven by induction motors, all of the latter should have the same full-load slip to ensure proper division of load.

FREQUENCY CHANGERS

The division of load between A. C. generators driven by synchronous motors introduces some interesting points. The problem is somewhat different from all other cases of parallel operation because the speed regulation of the prime movers, that is the synchronous motors, is zero.

The proper division of load has, therefore, to be secured in a somewhat different way than in the case of other prime movers, where a certain drop in speed is required in order to make a generator take its share of the load. The relative position of the field poles upon the low frequency and high frequency ends of two or more frequency changers, which are to be paralleled, is very important. If the rotators are not mounted upon the shafts so that the angular position of the low-frequency rotor is in exactly the same relation to high-frequency rotor, upon all the machines it will be absolutely impossible to make the machines divide the load properly. The conditions are very much the same as if the rotors of a number of generators were all rigidly mounted upon one shaft in which case, if the pole pieces on the different rotors are exactly in line, they will divide the load equally, whereas if one rotor is mounted so that its poles are slightly ahead of the poles on the other rotors, then the generator to which the first rotor belongs will take more than its share of the load. Varying the field excitation of the generator ends of the frequency changers will not alter the distribution of load, but will simply cause wattless currents to flow between the machines.

Care should also be taken that the sets are sychronized correctly upon both ends. This is a simple matter upon 30 to 60-cycle sets, for however the 30-cycle ends of the two sets are synchronized, the 60-cycle ends must be in step. In case of a 25 to 60-cycle set running at 300 r.p.m. (by the way, 300 r.p.m. is practically the only speed at which you can run a 25 to 60-cycle synchronous frequency changer on account of the necessary relation of the number of poles) having 10 poles on the 25-cycle end and 24 poles upon the 60-cycle end, there is one particular pair of poles on the 25-cycle end of one set, which has to come into proper relation with the corresponding pair of poles on the second set in order to have the 60-cycle ends of the two sets synchronize properly. As there are five pair of poles upon the 25-cycle end there is one chance in five of the 60-cycle ends being in step, after the 25-cycle ends are thrown together. If the 60-cycle ends are not in step, pull out the 25-cycle ends, slip one pair of poles on the 25-cycle ends and throw in again. This may have to be done four times before the 60-cycle ends are in step.

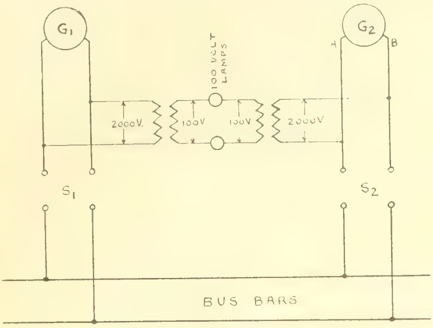

FIG. 1

I trust that we may hear something further regarding the parallel operation of frequency changers from some of the engineers of the Shawinigan Company to whom this is a daily operation.

SYNCHRONIZING CONNECTIONS

When two machines are to be connected up for parallel running, they should be tested out to make sure that the connections are all right. For this purpose a couple of small lighting transformers and incandescent lamps are required to be connected up, as shown in figure No. 1. According to these connections the generators will be in step, when the synchronizing lamps are dark. In order to make sure of this, disconnect the terminals of generator G-2, at A and B, from the leads running to the generator switch S-2, bring generator G-1 up to speed, and excite the field. Close generator switches S-1 and S-2, and the indication which is now observed on the synchronizing lamps is the one to be observed at the moment of paralleling the machines—i.e., if the lamps are dark now, they must be dark when the machines are paralleled. If they are bright now, they must be bright when the machines are paralleled. If lamps are bright

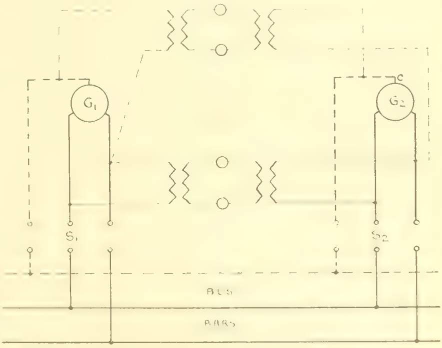

FIG. 2

and we wish to synchronize with lamps dark, reverse the connections between one pair of the generator leads and the transformer connected thereto. Open the generator switches, connect terminals of generator G-2 to the leads running to the generator switch. The generators are now ready to be paralleled. In the case of a three-phase machine, we have to test out one of the other phases.

See figure No. 2, in which the full lines show the connections used in testing out the first phase in exactly the same way as for two single-phase generators, while the dotted lines show the third terminal and the connections for testing out the second phase. This can be done by connecting up another pair of transformers and synchronizing lamps on one of the other phases, as shown by the dotted lines in figure No. 2. This second set of synchronizing lamps should be tested out in the same way as the first set was tested, then with one generator switch open and both generators fully excited and at full speed, watch both sets of synchronizing lamps. If all four lamps are bright at the same time, and all are dark at the same time, the connections are right. Now when in changing from dark to light having a period of several the lamps indicate synchronism, the beats of the lamps seconds, and voltage of the two generators is the same, the second generator switch can be thrown in and the machines are now running in parallel. After the connections have been tested out this first time, only one set of sychronizing lamps will be required for future operation. If one pair of synchronizing lamps, mentioned above, are bright when the other pair are dark, then it will be necessary to reverse one phase of the generator—i.e., any two leads at the terminals of one generator. After this has been done, it will be found that all four synchronizing lamps are bright, and all are dark at the same time, and the machines are properly connected for synchronizing. It is not necessary to test out the third phase of three-phase generators, for if two phases are right the third phase must be. It is necessary to test out both phases of two-phase machines, and if one phase proves to be wrongly connected, reverse the two wires of one phase of one of the generators. A somewhat simpler way than that above mentioned to test out the second phase after the first phase has been tested out is to disconnect from one of the generators the lead which has not yet been tested out. In figure No. 2 it will be the lead C. If both generator switches be closed you will then have three poles of one generator and two poles of the other generator connected to the bus bars, and the generators will be running in parallel on one phase. There should now exist no difference of potential between the generator lead and generator terminal where the circuit has been opened, if the connections are correct on all phases. This can be tested out by means of a small lighting transformer and lamp, or by means of a fuse, if it is carefully handled. If you get voltage across these terminals, reverse the two wires of one phase of one generator, and the machines will be properly connected for synchronizing. Two-phase machines would be tested out in practically the same way.

A word might be said here as to the conditions under which it is necessary to reverse the connections of alternators, which are run in parallel. If the direction of rotation of one of the generators is reversed, the two wires of one phase of one generator will have to be reversed. If the direction of field current is reversed in one generator, no change is required in the armature connections.

There are several synchronism indicators on the market under the names of "Synchronizer," "Synchroscope," etc. These devices are an improvement over the ordinary synchronizing lamps because they indicate the exact point of synchronism, they indicate whether the incoming generator is running too fast or too slow, and they also indicate the amount the incoming generator is too fast or too slow. The lamps do not indicate whether the incoming generator is too fast or too slow, and do not indicate the other points as perfectly as the synchroscope does. Considerable difference in phase is required to make the lamps glow, so that two machines may be at least 30 degrees out of phase without the lamps showing any difference in phase between them. On larger and more important plants, synchroscopes should be installed, as the generators can be synchronized with them both more accurately and more rapidly than can be done with lamps. Lamps should also be installed to fall back upon in case the synchroscope is out of order. In most small plants, lamps are quite satisfactory for synchronizing, and the extra cost of the synchroscope is hardly justified.

The synchroscope, of course, is only an indicating instrument, the actual paralleling of the machines having to be done by hand at the proper moment. An automatic synchronizer has very recently been gotten out which automatically closes the generator switch when the machines are in step. It evidently has no attachment for increasing or decreasing the speed of the generator to bring it into step, but simply connects the generator to the bus bars at the right moment. The use of this instrument would be a refinement which would be used only in the larger stations, and in fact, as designed at present, can only be used in connection with electrically-operated switches.

There are a few other miscellaneous points I would like to bring up, some of which should more properly have been taken up earlier, but, as this paper was prepared rather hurriedly, they have slipped out of their proper order.

First of all as regards governors: Some of the difficulties in parallel operation are due to the fact that the governors of the prime movers are too sensitive, causing hunting to take place. The addition of a dash pot so that the governor cannot act too quickly will often remedy this trouble. There is necessarily an interval of time between the commencement of the governor action and the change of speed resulting from the effect of such action on the steam supply. Now, if the governor is so very sensitive that the variation in angular velocity, due to uneven crank effort, causes it to act, then the result of that action will occur at the wrong time, probably when the variation in angular velocity is in the other direction. This action of the governor will aggravate matters and will cause the speed to see-saw up and down, and make parallel operation very unsatisfactory, and, perhaps, impossible. Now, if a dash pot be attached to the governor, so as to make the action of the governor so sluggish that the variation in angular velocity, due to uneven crank effort, will not allow the governor to act on the steam rupply, this see-sawing will be eliminated. The dash pot action should not be stiff enough to prevent the governor from responding fairly quickly in cases of actual change in load upon the engine.

In many water-power plants, several units will carry full load continuously and only one unit will carry the fluctuations in the load, the governor on this one unit doing all the regulating. The governors of the steadily-loaded machines are set so as to only operate if the speed of these units gets slightly above the speed at which the single governor would act, so that they only operate when the load has gone almost entirely off the machine that usually does the regulating. This prevents hunting of the different governors, which may occur if they are all ready to operate at every change in load on the system.

A small reversing direct-current motor is frequently used to change the adjustment of the governor, and thus increase or decrease the speed of the engine or water-wheel. This motor is controlled from the switchboard. It affords a means of synchronizing the generators and of increasing the speed of the generator that has just been paralleled, so that it will take its share of the load. However, in many cases the speed of the engine is adjusted when synchronizing simply by throttling down the light engine.

Generators in power houses some distance apart can usually be run in parallel quite satisfactorily, the inductance of the lines between the stations preventing excessive cross currents. One point in particular has to be watched, and this also applies where a number of generators are operated in parallel in one station. That is, the field excitation of all the different generators must be properly adjusted, otherwise cross currents will exist. Power factor meters upon the generator panels afford a ready means of determining whether the field excitation is properly adjusted. Indicating wattmeters on the generator panels are also of service for this purpose.

In one power station recently completed, where there are a number of similar generators, all the generator field rheostats can be thrown into gear with a shaft running under the operating table of the switchboard. The shaft is driven by a small direct-current motor, so that the excitation of all the generators can be increased or decreased at the same time and by the same amount. I know of three water-power stations within a mile of each other, in each of which are two 200-k.w. generators. All these machines are thrown in parallel from time to time without the use of phase lamps.

A compensated field generator will not run satisfactorily in parallel under varying load with a generator of the ordinary type not having a compensated field for the reason that when the load comes on, the voltage of one machine remains the same or increases while the voltage of the other machine drops, thus setting up cross currents with every change of load.

A scheme that has been used more than once in cases of emergency, is to help out a polyphase system by throwing single-phase generators onto the different phases of the bus bars. If a polyphase rotary converter is connected to the bus bars, you can disconnect all the polyphase generators and depend upon the rotary to ensure the proper phase relations between the single-phase generators, so that a polyphase load of amount equal to the output of the single-phase alternators can be carried; in fact, part of the load might be in the form of direct current from the rotary.

A quick means of paralleling a number of generators in one station, after a complete shut-down has occurred, is to run all the generators at full speed, cut the exciter voltage down very low, close all the generator field switches and bring the voltage up on the exciter. As the generator voltage rises they will all pull into step.

An interesting example in parallel operation occurred in a water-power station containing two 1,000-k.w. and two 2,000-k.w., two-phase, 2,300-volt generators. The latter had to be rebuilt as three-phase generators, but as the station had to be operated continuously only one generator at a time could be taken out of service. The step-up transformers were Scott connected so as to step up to 20,000 volts, three-phase for transmission. When one of the 2,000-k.w. generators had been rebuilt as a three-phase machine, it became necessary to operate it in connection with the remaining generators. The whole power house system was then changed over to three-phase in the following manner. We took one of the 1,000-k.w., two-phase generators, the armature of which had 40 coils per phase, and cut out five coils or $12\frac{1}{2}$ per cent. of the armature winding of one phase. One end of the winding of this shortened phase was tapped into the centre of winding of other phase in the same way that transformers are Scott connected in transforming from three-phase to two-phase. The machine now delivered three-phase current, two of the phases having a voltage of slightly less than one per cent higher than that of the third phase. Both of the 1,000-k.w. generators were connected in this way, and were run for several weeks in parallel with one of the 2,000-k.w., three-phase generators without any noticeable cross currents or unbalancing of the voltage on different phases. In fact, we were operating one delta-connected, one "Y"-connected, and one "T"-connected generator in parallel with perfect satisfaction for some days. The station was shut down for six hours when the change was made from two-phase to three-phase. During this time two generators were "T" connected, 20 step-up transformers were changed from Scott connection and arranged in delta, changes were made in switchboard wiring, and certain changes were made in the sub-station transformer connections. As there was a double set of generator bus bars and two transmission lines, this change could have been made without shutting down the plant at all had it been absolutely necessary to do so. The reason that the machines were rebuilt instead of being simply "T" connected for permanent operation in this manner as three-phase generators, was that by careful design the machines as rebuilt for three phase had a larger output than they had previously as two-phase generators. The output of the 1,000-k.w. generators when "T" connected was reduced to 870 k.w., whereas when rebuilt as three-phase generators their output was increased to 1,100 k.w.

ECONOMY OF ELECTRIC PUMPING.

Pumping of water for the supply of cities and town is a very desirable class of work for electric systems, where the reservoir capacity is such that the pumps can be kept in nearly constant operation at full load.

The desirable nature of this load is, of course, due to the fact that it can be carried by generating equipment which would otherwise be idle a great part of the time. If the electric system concerned operates in large part with water power, the work of pumping water supplies is especially attractive, because it can be done in a greater or less degree with water that would otherwise go to waste over the dam, between midnight and noon, on many days of a year. In view of these facts, electric systems are warranted in making very low rates for nearly continuous pumping service.

An interesting example of this sort is that in a large city where the electric company has taken the contract to pump 700 million gallons of water per month, under a head of 200 feet, at the rate of $4.50 per million gallons. This work is to be done with a pump that has a daily capacity of twenty-five million gallons, when operated twenty-four hours, and the pump must thus be kept in nearly constant service in order to raise 700 million gallons of water per month.

While 200 feet, including a lift of eighteen feet, is the maximum head against which the pumps have to work in this case, the head for a part of the service is as low as 133 feet, and the rate of $4.50 per million gallons pumped decreases directly with the head. Thus at 133.3 feet of head the rate is $3 per million gallons. As the weight of water is about 8.3 pounds per gallon, the work done in raising one million gallons against a head of 200 feet amounts to 1,660,000,000 foot-pounds. With the equivalent of 2,654,400 foot-pounds per kilowatt-hour, the work of raising one million gallons against a head of 200 feet reduces to 625.4 kilowatt-hours. With an efficiency of ninety per cent. for the electric motor, and of eighty per cent. for the centrifugal pump that is used for this work, or a combined efficiency of seventy-two per cent. for both, the actual work done must amount to 868 kilowatt-hours per million gallons of water pumped. Dividing the sum of $4.50 paid per million gallons pumped by the number just found gives the rate of 0.518 cent per kilowatt-hour for the work.

As the motor with its connected pump has a capacity to raise twenty-five million gallons during each twenty-four hours, when working under a head of 200 feet, the capacity of the motor should be 723 horse-power, if the assumed efficiencies for the motor and pump are correct. When the motor and pump are operated continuously at full load during twenty-four hours, raising twenty-five million gallons of water under a head of 200 feet, the cost of electric energy consumed by the motor will reach $112.50, on the basis just named. The equipment adopted for this pumping consists of a direct-connected motor and pump with vertical shaft. Current reaches the motor at 2,200 volts, twenty-five cycles, three-phase. Before the electric motor and centrifugal pumps were installed, an estimate was made of the total cost of pumping with electric and with steam power. The twenty-five million gallons per day to be raised by the new pump is merely an addition to the city supply, and the cost of pumping with steam power, as to merely operating expenses, was taken from the records of the pumping station for the fiscal year of 1903. During that year the quantity of water pumped by steam power was much greater than 700 million gallons per month, the rate at which the new pumps were to work. From the records of 1903, the cost of operation per million gallons of water pumped under a head of 200 feet was found to be $4.66. The estimated cost of additional steam pumps and boilers with a capacity of twenty-five million gallons daily was $137,500, and interest and depreciation on this sum at the rate of eight per cent. yearly amount to $1.18 per million gallons. This brings the total cost of pumping water by steam power up to $5.84 per million gallons.

For the electrically driven pump the estimated cost was $35,000, and the combined annual interest and depreciation on this sum at eight per cent. represents 30.7 cents per million gallons pumped. From the records of the steam-power pumping plant during 1903, it was found that the proportionate labor cost of operation for one pump in the engine room was $4,187.77 per year, and this sum represents 45.9 cents per million gallons with a pump of twenty-five million gallons daily capacity. Starting with the charge of $4.50 per million gallons of water, for electric energy to operate the motor, the labor charge in the engine room and the sum of interest and depreciation, bring the entire cost of electric pumping up to $5.27 per million gallons. Comparing this sum with the cost of $5.84 per million gallons pumped with steam power, it seems that the use of electric energy for pumping effects a saving in this case of fifty-seven cents per million gallons. On the basis of 700 million gallons of water per month, this saving in the cost of pumping amounts to $4,788 yearly, if all the work is done under the head of 200 feet. At lower heads the saving in favor of electric pumping is still greater per million gallons, because the energy rate for the electric pumping drops in direct proportion to the head, and the greater fixed charge against the steam-power plant remains constant.

The cost of coal at the pumping station in question was $2.13 per ton during the year of 1903, and the consumption amounted to 1.32 tons per million gallons of water pumped, when reduced to a uniform head of 200 feet. The total cost of coal including the cost of handling it and caring for the boilers, without any allowance for the time of the engineers, was $3 per ton, or about $4 per million gallons of water pumped under a head of 200 feet. In the computation of these comparative costs, the electric pump was charged as much as a steam pump for attendance in the engine room, but as a matter of fact the advantage in this regard would be with the electric equipment. The cost of $2.13 per ton for delivered coal in this case is below that in many places, and with higher prices for coal the saving of electric pumping at the rate named would be still greater.—Electrical Review.

UNIQUE POWER PLANTS.

Our representative had the opportunity recently of looking over two installations of Campbell gas engines and suction gas plants. The first of these is a 26 brake horse power Campbell engine, electric lighting type, with suction gas plant of same size. The engine is of exceptionally heavy design and for the power given it is probably the heaviest gas engine running in the Dominion ; the fly wheel weighing nearly 7,000 lbs. The charge is ignited by means of a magneto of very simple but apparently very efficient type, no battery or dynamo is used and the spark is perfect even in starting. The suction gas plant is very simple in design and working and sufficient gas is produced from less than 250 lbs. of coal per day. This plant is installed at the works of the Ryall Screw & Specialty Company, Montreal.

The second installation consists of a 20 brake horse power engine of the same electric lighting type, and although differing in minor details from the 26 h. p., it is essentially the same. This plant is running in the machine shops of Messrs. Beauvais Bros., who are makers of agricultural implements at Laprairie, Que. They are highly pleased with their engine.

Both plants were installed by the Canadian agents of the Campbell Company, Messrs. Wayland Williams & Dadson, 321 St. James Street, Montreal.

The Monarch Supply Company, Limited, has been incorporated in Toronto, with a capital of $6,000, to construct works for the production and distribution of electricity. The provisional directors are Messrs. J. S. Lovell, Wm. Bain, Robert Gowan, E. W. McNeill and W. F. Ralph.

The contract for the hydraulic and electrical machinery for the City of Nelson power plant on the Kootenay River has been awarded to Allis-Chalmers-Bullock, Limited, Montreal. The tenders were: Canadian General Electric Co., $32,000 for the electrical machinery; Canadian Westinghouse Co., $31,376 for the electrical machinery; and Allis-Chalmers-Bullock, Limited, $29,985 for the electrical and $13,600 for the hydraulic machiner

THE CARE AND MANAGEMENT OF LEATHER BELTS.

By Walter F. Dixon, M. E.

Outside of the direct care and management of high-pressure boilers and the steam lines pertaining thereto, there is no part of a power or lighting plant, mill or factory in which a large number of indirect connected machines are used that is of such vital importance as leather belting and rope drives. The subject under discussion in this paper will be the former, the selection, care and management thereof, while that of rope drives will be considered at some future time.

The first thing in order will be the selection of a leather belt, and when we consider that all makers make good belts, that there are no particular secrets in the belt-making business, and that in order to get the very best we must take every advantage of all small details in construction, it stands every engineer and belt user in hand to get all the information available, for we must remember that the percentage of good hides does not run very high, that all that are bought go into belt stock of some kind or other, and that someone must buy the goods that are not quite up to the standard of belt excellence. It is very evident that no man wants anything but the best when he is paying for the best, and it is also evident that no maker is going to say that he makes inferior goods; so therefore we must read the quality by what is in sight, and in the judging of leather that is already made up, the proposition resolves itself into a very hard one.

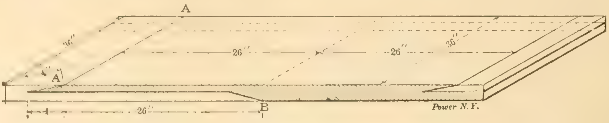

FIG. 1.

The two principal things left for an opinion to be based on as to quality are the relation the pieces that constitute the laps bear to the hide from which they were cut. They should, in belts running from 18 to 36 inches, be cut from the center of the hides, or should be what is known as "center stock." Of course all belts should be "center stock," but where they are very narrow or so wide that one hide will not be wide enough to make a lap, then there is always a lot of narrow stock worked in that cannot always be strictly center. The next thing to look out for is brands that are so deep that they destroy the life of the leather and will cause it to break after being used. Then look out for the length of lap. If this is too long, you will know that it runs into the neck, for about all that is possibie to get out of average hides and still leave nothing in that is not first class is 54 or 56 inches. Ordinarily, you can tell if a lap is "center stock" by the marks that run down either side of the back bone; they will be usually a little darker than the rest of the belt. These marks or streaks should be in the center of the belt. The principal objection to neck leather is that it is liable to stretch excessively, and on this account it will put too much load on the piece immediately opposite it in a double-ply belt; for the point of one side is in the middle of the lap on the other side. Next look out for holes, which will usually be found so nicely plugged as to escape detection unless subjected to the most careful examination.

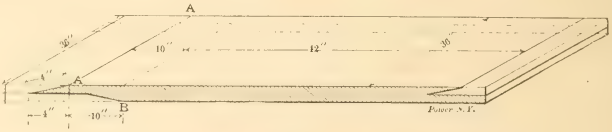

FIG. 2.

Next in importance is to buy a belt that has already been filled with some good waterproof dressing. Now I am quite ready to admit that to buy a belt that has been filled means to buy one that perhaps has some bad leather in it that would be seen in a dry oak tan belt, and also that the adhesive power of the filled belt is not quite equal to the dry one, but the points that the filled one possesses over the one not filled are, first and mainly, "it is filled with a preparation when you buy it that does not injure the leather in the least," and the preparation you will fill it with, for it will be filled, will be engine oil and water, a combination that will ruin any belt made, and also get it in a condition in six months that will make a permanent repair with glue impossible, for machine oil and moisture are strangers to glue and will ever be. More good belts are ruined by being soaked with engine oil until the points come loose and then pulled out of shape than from any other cause. Of course *you* may be able to keep a main engine belt that runs through a damp wheel pit and basement, and through a long damp tunnel to a main driven pulley that has two big boxes that are just as close to the pulley as a first-class machine designer could put them, and never get a drop of oil or water on it. If you can, I take off my hat to you; you are a wonder and in a class by yourself where you will ever be lonesome.

One very common cause of trouble with engine belts is the fact that such belts usually run under the floor where there is considerable moisture, and then the oil table under the average large Corliss engine will leak around dash-pots and rocker-arm shafts, and some oil will fly from the eccentric oil cups and get into the wheel and run around the rim and get to the belt, and if the belt is not filled a very few drops of oil will make a large spot on it. Then, if an engine does not run the whole twenty-four hours, while it is off, watch. A few drops of water from a leaky valve stem whose bonnet drain is stopped up, as they will sometimes be, has a way of getting through the floor and falling on to the belt and running down the inclined inside of it until it finally comes to the flywheel, which, with the assistance of its crowning face, very kindly makes a nice pocket for said water and proceeds to drink it up. Result: the glue is loosened and the belt may come apart in consequence. And should there chance to be a point just at the bottom of this pocket, it will get the glue soft enough to slip but may not open up, which is much worse than if it did open up, for it may slip away from the shoulder of the splice for half an inch, and when the engine is put to work it may close down by running under the wheel and stick, and, if it does, the result is that at no very distant day you will find a break at that particular place, right across the face of the belt. The reason is that the load was all taken off the inside half of the belt by point slipping, thereby making the inside of the belt too long and putting all the load on the out side. The outside will continue to do all the work until it stretches enough to bring the inside back into service again. During this week or month you have been pulling your load with a single belt, not a double one, and after a short time you will find the break I referred to above in the shape of a clean, well-defined crack extending across the belt parallel with the points of the laps. Now of course you are going to send for the man who sold you the belt and ask him to fix it. If he is a wise man and understand his business, he won't do a thing but show you right under that crack a point that does not come up to where it should come. Then the thing for you to do is to say to him that the belt is examined every time it is put into service and that you have noticed that the points he refers to all come loose during a "run" and that anyone knows that a few drops of water would not take any belt to pieces while t was running, and if it was water, why did it not take it apart everywhere, etc.? And finally crush him completely by telling him that your men have no time to put a pair of clamps on a belt in order to pull every point that comes loose back into its proper position, and that if they did do it they would have no time for anything else, especially in the present case, and that if his people had made the belt right the glue would have held, anyway.

After he has given you a new belt or repaired your old one, just take my advice and box that flywheel up above the top of the eccentric oil cup, at least 12 inches, and get some good, heavy tin or zinc and put a tight roof over the belt, under the floor.

First put in a ridge pole out of 1½-inch pipe, starting at the face of the wheel and running in the direction of the main driven pulley, holding it firmly in place at each end with a strong iron clamp. Then solder in each edge of the strip of tin, which should be long enough to reach beyond any possible leak through the floor or oil table, a piece of ½-inch pipe, and put tin over the ridge pole with a piece of small pipe on either side. Ordinarily the belt goes out past the cylinder, and if it runs through a bricked-up runway on its route to the main driven pulley, just fasten the two pieces of ½-inch pipe to either wall and have the ridge about 6 inches higher than the outside ones, and then every drop of oil or water that comes through the floor will fall on to the roof and run down to the walls and be carried down to the floor of the pit and have no chance to touch the belt.

One of the most difficult things in the operation of large stations where a large number of belts are used is to keep them thoroughly clean and free from moisture and machine oil, the latter especially. One very hard problem that confronts the designer of all machinery is the prevention of oil leakage from boxes. I have seen plants where as many as six dynamos of the same kind were in use and not one single departure from each other in the way of design, and in the six there were at least four that I know of that leaked oil every time they were run. The others did not leak as a usual thing, and all were equipped with the most modern methods of holding oil.

Now we come to the building of the belt, and we will notice only such points as interest the engineer or buyer. The first thing is to see that the laps are of uniform thickness, so that the belt will run quietly, and it should be absolutely straight when unrolled on the floor. If it has a long, graceful curve in it, look out, for it will not run straight on the pulleys until it has stretched straight, and by that time one of its edges may be ruined by coming in contact with the floor or some other obstacle. Next notice how long the leather is from which it is made. It should not show more than 52 inches, and then there will be 4 inches hidden by the point that is out of sight. Then see that the joints are broken properly. For instance, find the center of any piece of leather on one side of the belt, and then look on the opposite side and see if the joint is right under your center mark. It should be by all means, for right here lies the most important thing about the construction of leather belts. A belt whose laps are all the same length, and which has all its joints broken correctly, will put the same load on the glue throughout, and that is what must be done in order to get best results. See Fig. 1. Here we have a belt that is 36 inches in width and a double ply. Now, suppose there is a draft of 9,360 pounds on this belt, and from point *A* to point *B* is 26 inches, and the points are 4 inches long. Now we have 26 inches plus 4 inches plus 4 inches times 36 inches for the number of square inches in the glued joint. This equals 1,224 square inches, and the total pull on the belt divided by 1,224 will equal the load on each square inch of glued joint, and will equal in this case 7.65 pounds. Now if instead of distance *A—B* in Fig. 1 being 26 inches let the lower joint get out of step with the upper ones, and conditions get vastly different. We will suppose that the dimensions are as they are given in Fig. 2, which are taken from a new belt that I measured less than one month ago, and we have the following: Joint *A B* now is only 10 inches, and we have 10 inches plus 4 inches plus 4 inches times 36 inches = 648 square inches, and the load on the joint is now 14.44 pounds. You will readily perceive what an important part in the life of the belt, and the life of everything around the belt as far as that goes, the proper breaking of the upper and lower joints is. Of course the belt maker will tell you that his glue is just as strong as the leather itself, and I will admit that he is about right as long as you keep the belt free from oil and water, but when the belt becomes filled with oil the glue rots and loses its strength much faster than does the leather.

No good belt needs any posts along the sides to make it run straight and stay on the pulleys. I have my first belt to see in the last fifteen years that would not run absolutely straight if the pulleys were in line and the belt straight.

All belts should be made to run perfectly straight on pulleys, first on account of the local advertisement that it gives to the man who has charge of them, and, second, if they do not run true and ever slip, they will be on the floor or wrapped around the shaft in a very few minutes. Another very important thing in the care of belts that carry heavy loads is that if any of the points do come loose so far back they will not return to place without putting on the clamps; put them on by all means, as the restoring of this point to place means that you will still retain in service all of your belt, as you will not do if you glue it down where it is and thereby cut one side completely out of service.—Power.

THE FRASER VALLEY ELECTRIC RAILWAY & POWER COMPANY.

A goodly number of shareholders were in attendance at the first annual general meeting of the Chilliwack Power and Light Company, held in the town of Chilliwack, B.C., on July 10. In the absence of President Thos. Stout, of Rossland, Mr. J. Burtt Morgan, the general manager, occupied the chair.

In his report, he dealt with the widespread interest that is being taken in the proposed electric railway, and declared that it marked a new epoch in the history of the development of this justly termed "Garden of British Columbia." Speaking of what had been accomplished during the past year, he stated that by-laws had been passed by the municipalities of Chilliwack, Sumas, Matsqui and Langley, granting important and valuable franchises to the company. A proposal had been submitted to the Premier that the Government should guarantee the interest on a bond issue not to exceed $750,000, and with interest not exceeding 5 per cent. per annum, the company to place 40 per cent. of the gross earnings of the line at the disposal of the Government to cover this guarantee. With the company organization completed, he was confident that they would receive substantial recognition. A gratifying feature was the fact that over $25,000 worth of stock had been subscribed by residents in the sections through which the line would pass, and only half of these sections had been canvassed.

It was decided to change the name of the company to the Fraser Valley Electric Railway and Power Company, Limited.

Application will be made to the Municipal Council of Chilliwack for the submission to the voters of an amendment to the "Chilliwack Tram, Power & Light By-law 1904" granting an extension of time for the commencement of the construction of both electric power plant and electric railway to January 1st, 1906, and an extension of the time for the completion of same to January 1st, 1908. This extension is rendered necessary owing to the time consumed in securing franchises from the other municipalities.

It was decided that the directors should place engineers upon the survey of the route of the proposed line as soon as they deem wise.

The following officers were chosen for the ensuing year: President, Geo. R. Ashwell, Chilliwack, B.C.; first vice-president, W. H. Vanderhoof, Sumas, Wash.; second vice-president, E. C. Rose, Rossland, B.C.; treasurer, W. L. Macken, Chilliwack, B.C.; secretary and general manager, J. Burtt Morgan, Chilliwack.

SPARKS.

The Power & Gas Machine Company, Limited, has been organized at Galt, Ont., to manufacture a gas engine invented by Mr. W. H. Cone.

Specifications have been prepared by the City Engineer for street lighting in Toronto for the next ten years, and tenders will be invited in the near future.

The electric light power house at Glace Bay, N.S., is now under construction, the contract having been given to Mr. Hugh Cameron, whose tender was $7,600.

The negotiations between the city of Calgary, N.W.T., and Mr. Grant, of Macleod, for the supply of electric power by the latter have fallen through, the city insisting upon a five year agreement while Mr. Grant would accept nothing less than [illegible] years.

Mr. D. D. Mann, of the Canadian Northern Railway, has purchased the St. Leon Springs Hotel property at St. Leon Springs, Assumption County, Que., and will, it is said, connect the place with the Great Northern railroad by an electric line. The distance is six miles.

ROBB-ARMSTRONG CORLISS ENGINES: SLOW AND MEDIUM SPEED.

The Robb-Armstrong Corliss engine is designed on the lines of standard Corliss engines of the modern, heavy duty type, the stroke being rather short, giving a compact frame, free from the vibration which always takes place in the older design of long stroke, girder frame. As shown by the cut, Fig. 1, the frame is supported the whole length on the foundation; the crosshead guides and main bearing seats being bored in a special machine at one operation, making them in perfect alignment. The length of stroke is so proportioned that the revolutions of the engines may be anywhere from 90 to 150, and the speed of pistons and reciprocating parts does not exceed 450 to 600 feet per minute, which is very desirable for use in factories, saw mills, etc., where continuous service is required with the minimum amount of attention.

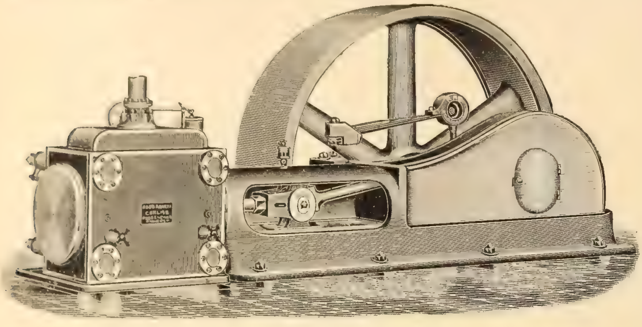

FIG. 1.—ROBB-ARMSTRONG ENGINE.

The special feature of this type of engine is the Armstrong-Corliss valve gear, which is much more simple in construction than the ordinary releasing gear, and will operate successfully at any speed up to 200 revolutions per minute.

The valve gear shown in the outline sketch, Fig. 2, is the invention of Mr. E. J. Armstrong, M.E., the essential feature of it being that there are no springs, dash pots or disengaging parts which are usual in the ordinary Corliss valve gear. By the introduction of two small links, A and B, between the wrist plate and bell cranks, the steam valves are caused to open and close quickly, and remain stationary during the remainder of the stroke, the action being almost precisely the same as with the releasing gear invented by George H Corliss, the advantage being that as this valve gear is positively driven, and does not depend on springs or dash pots for closing, it may be operated at much higher speed than the releasing valve gear, and as there are only about half as many pieces and wearing surfaces, and no latches or detachable parts, the gear runs very smoothly without noise or friction. The valves are of the usual Corliss rotative type, triple ported, of the latest design, giving very short travel and quick opening. The exhaust valves are driven from a wrist plate in the usual way.

The automatic cut off is obtained by means of a shaft governor, located in the driving wheel of the engine, so arranged that the position of the eccentric is varied, changing the cut off of the valves directly. This method of governing is much more positive, quicker in action and gives a closer regulation than the indirect method of governing used in connection with the releasing valve gear.

In the Robb-Armstrong-Sweet governor, the centrifugal weight is carried directly by the spring, so that the heavy strain due to centrifugal force is not brought on the suspension pin, which merely carries the eccentric, and is not subject to any strain or friction, except that due to the driving of the valve gear. The centrifugal weight may be very heavy without bringing undue strain on the spring, because a large part of its centrifugal force is carried by end pull on a flat lead spring, so that the inertia of the weight will be sufficient to prevent disturbance by the reciprocating motion of the valve gear, and the weight is so placed that it gets the effect of inertia for quick regulation. The governor system is in gravity balance in all positions, because the eccentric is made to balance the centrifugal weight, the principle of balancing being the same as that invented by Professor John E. Sweet and used in the "Straight Line" governor. The result is an extremely simple and powerful governor, in which there is not enough friction to prevent it from changing position almost instantly to meet sudden changes of load, and there is no possibility of racing when properly adjusted. By means of a simple adjustment of the link connecting the eccentric and centrifugal weight, the governor weight may be adjusted to any degree of sensitiveness or close regulation. Only an engineer who has had experience with various types of governors can properly appreciate the ease and certainty with which the necessary adjustments are made on this one, and the absolute integrity with which they are maintained. No other governor compares with it in these all essential qualities.

The crank shaft is made of the best quality of mild, forged steel and the crank disc of semi-steel or steel casting. The shaft is forced into the disc by hydraulic pressure, and as an extra precaution, a key is inserted between the shaft and disc. The crank pin is large in diameter in proportion to the length, so that the center of thrust is as close as possible to the shaft bearing, and springing of the crank minimized. The journals of the crank shaft and crank pin are carefully ground to gauge and lapped to perfect surface. The crank pin is oiled continuously by the waste oil from the shaft bearing, and also from the sight feed valve on the main bearing cap, the oil being caught in an annular recess at the back of the crank disc and conveyed to the crank pin, by centrifugal force, through the oil hole shown in the sectional cut of the main bearing and crank.

The shaft bearings consist of interchangeable, removable shells lined with genuine babbitt, made of pure copper, tin and antimony compressed into the outer cast iron shells and carefully bored and scraped to gauge. The shells are in halves, turned on the outside to fit seats in the frame of the engine, held to place and adjustable by wedges, as shown in the illustration. The adjustment is made by screws from the outside of the cap; by loosening the center screws which hold the top wedge, and tightening the side screws, which lift the side wedges and close in the shell or vice versa. The adjustment of the shells may be made by hand while the engine is running, which enables the engineer to feel the tightness and prevents getting the bearing too tight. By this arrangement, the shell is closed in evenly all round, keeping the contact of the bearing surfaces even and equal as wear takes place, which is not the case in the ordinary four part box. As the strain on the bearing is on the bottom and sides only, the top part of the shell is open and does not touch the shaft, which prevents heating and allows the oil to be well distributed over the bearing. The bearing shells are interchangeable and may be replaced at any time without delay, restoring the alignment of the crank shaft. The shaft bearings have

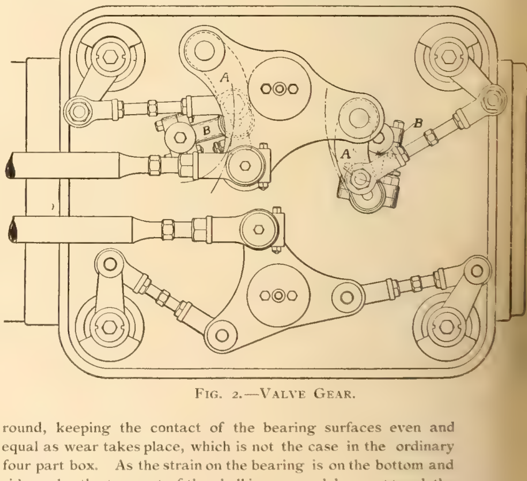

FIG. 2.—VALVE GEAR.

ring oiling in addition to the regular system of oiling, as described.

The connecting rod is solid steel forging, the crosshead end being solid without straps and the crank end either solid or of the marine type, the bearing surfaces being lined with genuine babbitt compressed into place, bored out and carefully scraped to gauge. The connecting rod boxes are interchangeable, so that they may be replaced at any time.

The crosshead is of the ordinary type, made of steel with an adjustable bottom shoe, which is lined with babbitt.

Large oil pockets are provided at each end of the guide, into which the crosshead shoe dips, so that it practically floats in oil.

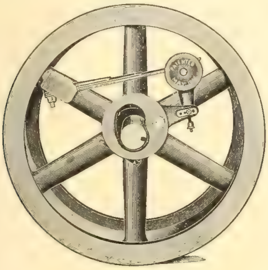

Fig. 3.—Governor.

A regular and copious supply of lubricant to all the working parts of an engine is perhaps more essential than any other detail to its successful and satisfactory working, as well as to its length of life. The continuous oiling of all the bearings of the Robb-Armstrong engine is provided for by a large reservoir placed on a pedestal above the engine, and the oil is piped to every bearing with a sight feed valve for each, which may be adjusted once for all, the entire oiling system being started or stopped by opening or shutting a single valve at the reservoir. As stated previously, the main bearings have ring oiling in addition to the sight drop, and the crank pin is also supplied in two ways. The oil is all returned to the crank pit, where it may be drawn off and filtered, or allowed to drain to a separator and filter attached to the engine. The frame and crank, as well as the eccentric, are entirely enclosed by sheet metal casings, which prevent the oil being thrown outside the engine. The cylinders are provided with positive feed lubricators.

The Robb-Armstrong engines are designed with the special object of being made in quantities by the interchangeable system. The drawings, gauges, templates and manufacturing plant are especially adapted for it and a large stock of duplicate parts always kept on hand. Every part of each engine is numbered, corresponding with drawings, which are placed in our files for reference, so that the customer may obtain duplicate parts at any time by telegraphing the number of the engine and part required.

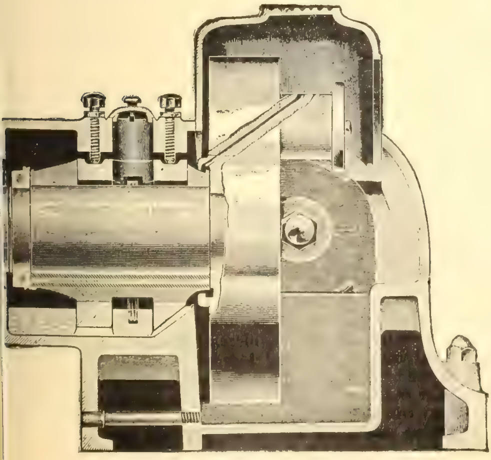

Fig. 4. Main Bearing and Crank.

The value and efficiency of a steam engine depends on its ability to do continuous, hard work, without undue wear or breakage, and be as economical as possible in the use of steam. The special features of the Robb-Armstrong Corliss engines are the improved valve gear, extreme simplicity in the number and arrangement of parts, and that every wearing part may be replaced, thus keeping the engine in perfect condition indefinitely.

SPARKS.

The City of Winnipeg is asking for tenders up to August 28th for supply of a 500 kilowatt generator.

The Matthews Turbine Company, Limited, of Toronto, has been incorporated with a capital of $100,000. Messrs. Ewen Mackenzie, Thomas Lawless, C. B. Jackes, J. P. Murray and J. P. Beaty are the provisional directors.

It is stated that the Montreal aud Southern Counties Company, having obtained right of way over the Victoria Bridge, intend to proceed at once with the construction of an electric railway line between Longueuil and Montreal.

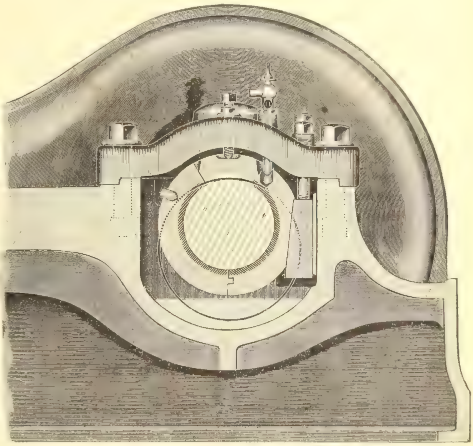

Fig. 5. Section Through Main Bearing.

The Trumbull Electric Mfg. Company, of Plainville, Conn., have received so many orders for their Type A switch in capacities higher than 600 amperes, that for the convenience of customers they have issued a supplement to their No. 5 Catalog, listing these switches up to 1,200 amperes. For use on switchboards and for controlling motors their Type A switch is claimed to have no equal.

The question of the development of electric power at Valleyfield and its transmission to Montreal is now being discussed. An electrical engineer who has made a study of such matters and who is familiar with the possibilities at Valleyfield thinks it quite possible to develop anywhere from forty to fifty thousand horse-power there. As for the transmission to Montreal, the proposition seems easy, as Shawinigan, Niagara Falls and other powers have fully demonstrated the feasibility of long distance transmission. The distance from Valleyfield to Montreal is 44 miles.

The Berlin Electric Company have recently installed a very complete power and lighting plant in Clare Bros. & Company's foundry at Preston. There are two 45 k.w. generators, of parallel operation, and four motors, one of 30 h.p., one of 12 and two of 5 h.p. The lighting is done by 300 incandescent and 16 series arc lamps. The wiring is the two-wire system, 250 volts. The Berlin Electric Company have also installed a modern plant for the Berlin Felt Boot Company, consisting of a 65 k.w. generator, five 5 h.p. motors, three 10 h.p. motors and two 7½ h.p. motors, also 500 incandescent lights, 250-volt system. Westinghouse apparatus has been used throughout in the above plants, which were installed by Mr. T. E. Hamilton, of the Berlin Electric Company.

THE ONTARIO HYDRO-ELECTRIC COMMISSION.

The power commission appointed by the Ontario Government, as announced in the July issue, have already commenced its investigations in a very active manner, and a vast amount of information is being collected. The Commission will be known as the Ontario Hydro-Electric Commission. Hon. Adam Beck, M. P. P., has been named as chairman, while the two other members are Mr. George Pattinson, M. P. P., of Preston, and Mr. P. W. Ellis, Toronto. Mr. Cecil B. Smith, chairman of the Temiskaming and Northern Ontario Railway Commission, Toronto, has been chosen as chief engineer. Mr. Gordon Sproule, of Mr. Smith's office staff, has been appointed secretary of the Commission ; Mr. W. G. Chase, of St. Catharines, electrical expert, and Mr. Harold Acres, of Paris, hydraulic expert.

The Dommission will have joint offices with the Temiskaming and Northern Ontario Railway Commission, these having been secured in the National Life Chambers on Toronto street, Toronto.

The Order-in-Council directs the Commission to secure the following data :

"The present and probable demand for hydraulic and electric power in the various districts capable of being supplied from the different water powers within the legislative jurisdiction of the Province of Ontario.

"The location, capacity and capital cost of development o the various water powers within the legislative jurisdiction of the Province of Ontario at present undeveloped, but whose development is required to supply the present and probable needs of the surrounding district, and to ascertain the probable cost of the attendant transmission plants necessary to the utilization of electric or hydraulic power to be derived from the aforesaid water powers within the respective surrounding districts.

"To ascertain the rates or prices that would require to be charged, the various classes of consumers of hydraulic or electrical power within the respective districts, in order to meet all expenditure of maintenance and operation.

"To enquire into and ascertain the annual savings accruing to the consumers in the various districts aforesaid by the substitution of the rates or prices to be ascertained under the next preceding paragraph, for the rates paid at present in the said districts, so far as the commissioners may be able to ascertain or estimate them.

"To enquire into and ascertain the cash capital cost of the hydraulic and electrical power undertakings of existing companies located within the Province of Ontario; the capacity and state of development thereof, and to ascertain further: (a) The quantities of power supplied and contracted for and the rates charged, and to be charged, under such contracts by these companies for hydraulic or electric power. (b) The actual present value of the said undertakings, after making such fair and reasonable allowance for existing conditions as in the judgment of the commissioners seems necessary or expedient. (c) The estimated capital outlay, if any, necessary to complete these undertakings."

The first important question to be decided by the Hydro-Electric Commission will be the advisability of adopting electric power for the operation of the first section of the Temiskaming and Northern Ontario Railway, about 130 miles. It is understood that Mr. Bion J. Arnold, the electrical engineer, has recommended the adoption of the single-phase system as installed by the Westinghouse Company. A locomotive, built to be operated by this system, weighing 136 tons, has been demonstrated at Pittsburg to be equal to the heaviest strain ever placed on a draw bar.

The Commission left Toronto on August 9th to inspect the Kakabeka water power near Port Arthur, Ont.

TELEGRAPH and TELEPHONE

THE TELEPHONE IN BRITISH COLUMBIA.

The British Columbia Telephone Company, Limited, report a very rapid growth of the telephone system throughout the province. In Vancouver especially the telephone is enjoying somewhat of a boom.

The company are rebuilding the long distance lines in the Kootenay district and also the exchange in Nelson. At the latter place a new office building is in course of erection also.

The British Columbia Telephone Company have now direct connection with the Pacific States Telephone Company at the boundary line, also with the International Telephone Company at Bellingham. The latter company have an extensive system throughout the American territories and connect direct with Vancouver Island. A submarine cable has recently been laid giving the Vancouver Island subscribers connection with the mainland of British Columbia, as well as with Seattle, Tacoma and other exchanges of the Pacific States Telephone Company.

The British Columbia Telephone Company are making provision to put their wires underground in certain portions of the City of Vancouver, the underground system to extend from Burrard street on the west to Westminster avenue on the east. It is expected that this work will be started almost immediately. Contrary to the existing feeling in other cities, the mayor and aldermen of Vancouver have shown considerable opposition to this underground scheme.

THE BELL COMPANY IN MANITOBA.

The Bell Telephone Company continues to improve its system through the west. This month the company will complete a new long distance copper metallic line from Portage la Prairie to Neepawa with offices at Westbourne, Westbourne Landing, Gladstone and Arden. The company is now laying down poles on the highway for a long distance line from Regina to Indian Head, fifty miles, and from Regina to Lumsden, twenty-five miles. These poles are being shipped from British Columbia. The work of construction is to be commenced at once and rushed to completion. There is a large construction gang building a new long distance line from Killarney to Deloraine with an exchange at Boissevain and toll offices at Ninga and Whitewater. There is also a large construction gang engaged on a new long distance line from Elm Creek to Wawanesa with offices en route at St. Claude, Rathwell, Treherne, Holland, Cypress River, Glenboro and Stockton.

The Bell Company has recently opened a local exchange of forty-five subscribers at Killarney, and an exchange of thirty-five subscribers at Pilot Mound. It will also have completed in a few days a metallic line from Winnipeg to Carmen which will give a long distance metallic circuit direct from Miami to Winnipeg upon which new offices will be opened at Dacotah, Starbuck, Fannystelle and Elm Creek. This will open up a new outlet for the southwestern district of the province to the capital city.

The company has improved its long distance service by making the line from Morden to Pilot Mound metallic and adding a new copper metallic line between these points to meet the rapidly increasing toll business. The line between Morris and Morden has also been made metallic. An additional copper metallic long distance line from Winnipeg to Portage la Prairie just established, will not only relieve congestion of business between these points but will serve the new territory now being opened up by the company north of Portage la Prairie.

INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Electric Railway Systems.—At a recent meeting of the Verein Deutscher Ingenieure (Associations of German Engineers), held at Madgeburg, Dr. Eichberg, of Berlin, presented a paper dealing with the recent progress and future of electric train haulage. In the course of his observations, the author stated that the Prussian Railway Ministry had come to the conclusion that, from an electrotechnical point of view, neither the double overhead conductor nor the third rail was suitable for the working of trains on large railway networks. A technically satisfactory solution, as has been clearly proved by the experiments at Spindlersfeld, near Berlin, was afforded only by the combination of a single aerial wire with high pressure current and a single-phase motor. The same system had been employed with success in the Stubbai Valley, Innsbruck. It practically presented no material difficulties. A pressure of 5,000 volts to 6,000 volts had been used on the Spindlersfeld line, and it would be possible to employ a pressure as high as 15,000 volts on mountain railways. On the German line in question, electric heating had been adoped, the current being mostly used for this purpose while the trains were at rest, and also occasionally during running at full speed. The heating was regulated by a switch on the driver's platform. As a result of those experiments, the Prussian Railway Ministry had decided to introduce the single-phase system on the section connecting Hamburg, Blankenese and Ohlsdorf, which was to be set in operation in a year. It was intended to work the line at a pressure of 6,000 volts, the trains to be composed of motor-cars and trailers in accordance with the traffic requirements.

New Arc Lamp.—Heinrich Beck, of Meiningen, Germany, has invented and is now placing on the American market a new arc lamp, which is ingenious in several ways. The most striking point is in the fact that the carbons are arranged side by side at a slight angle, and the arc, which is gaseous, throws the whole illumination downward, from the under side of a small but specially designed reflector. It is asserted that the lamp gives 3,200 candle-power at a downward angle of 90 degrees, and a hemispherical illumination of 2,000 candle-power. When seen in operation the lamp was taking only 7½ amperes at 44 volts, but the inventor allows one ampere and one volt more. The mechanism is extremely simple. When not burning, the tips of the carbon rods touch each other at the lower ends, but when the current is applied a solenoid operates a counter weight and separates them. An adjusting screw maintains the tips at the proper distance apart. The positive carbon is of slightly larger diameter than the negative. When the arc is burning, a good deal of flame is seen, and there is some slight spluttering and falling of fused carbon, but this does not interfere with the steadiness of the light. In size and weight the lamp is much smaller than arc lamps of a similar illuminating power, but it is slightly longer from top to bottom. Exhaustive tests by Professor Wedding of Berlin show that the lamp will give eight candle-power per watt.

Voltmeter for both Direct and Alternating Current.—The Bristol Company, of Waterbury, Conn., have placed on the market a voltmeter that can be used equally well for recording either alternating or direct current. Some of the novel features and improvements of this new voltmeter are that it requires only one-third as much current to operate as that necessary for the older design for alternating current, it is more sensitive to slight variations of voltage, the chart graduations are nearly uniform on both sides of the working range, and the portable form of the instrument in its carrying case is of smaller size and less weight than the instrument formerly used. When current is passing through the two solenoids in series, the movable solenoid is repelled from, instead of being attracted toward, the stationary one, thus the mutual inductance between them is neutralized, and the instrument is suitable for recording either alternating or direct current. Its operation is independent of the rate of alternations and compensation is made for changes of atmospheric temperature.

Metallized Carbon Filament.—Mr. John W. Howell read a paper before the American Institute of Electrical Engineers dealing with a new type of carbon filaments. These filaments are made from the same material as the ordinary filament. They are also baked and treated in the same way, but they undergo an additional process known as firing. It is this last process which produces such surprising results. The common carbon filament, as is well known, is baked first in an oven so as to carbonize the cellulose. The filament thus prepared forms a base upon which later a coating of graphite is deposited in the flashing process. The additional step through which the metallized filaments are carried consists in heating filaments prepared and treated in the ordinary way to an exceedingly high temperature—a temperature so high that it can not be obtained satisfactorily by passing a current through the filament itself, but must be obtained by passing the filament through an electrically heated furnace. The effect of this treatment seems to be to bring about a metamorphosis of the graphite coating, the process taking but a few moments. The effect of this excessive heat on the carbon base of the filament is slight, but since it appears to cause a certain amount of gas to be given off, which blisters the graphite coating, it has been found preferable to fire the carbon base before it is treated. Mr. Howell states that the new lamp has a useful life of 500 hours, about the same as that of the 3.1 watt carbon lamp. On a basis of 2.5 watts per candle for the new lamp and with the price for energy at ten cents per kilowatt-hour, the metallized lamp should be worth about forty-eight cents more than the 3.1 watt lamp, a large figure when the cost of the latter lamp is considered.

SPARKS.

A by-law was carried at Palmerston, Ont., on August 8th, to raise $3,000 to improve the electric light plant.

The by-law to provide funds for extending the electric light plant at Victoria, B. C., has been sanctioned by the ratepayers.

The Manitoba Government have just taken tenders on a power plant for the new Agricultural College buildings to be erected at Winnipeg.

The Canadian Copper Company are developing a water power at High Falls, the intention being to transmit electric power to Copper Cliff, 25 miles distant, for use in mining operations.

Niagara Falls, Ont., is asking for tenders up to September 2nd for a pumping unit, to consist of a 5,000,000 gallon centrifugal pump direct-connected to a three-phase, 25 cycle, 2,200 volt motor.

The Western Counties Electric Company have applied to the Brantford City Council for a 25-year franchise to sell electric power in that city, the charge to be three-quarters of a cent per hour per horse power.

The Toronto Launch & Engine Company, Limited, has been incorporated, with a capital of $40,000. The provisional directors are Messrs. J. C. McLachlan, J. G. Robinson, G. E. Bucke, G. W. Hambly and R. G. Copeland.

The company which propose to develop the water power of the Kakabeka Falls near Fort William, Ont., will be known as the Kaministiquia Power Company, Limited, instead of the Kakabeka Power Company as stated in our July issue.

Mr. Frank Denton, K. C., Toronto, and Mr. Douglas, hydraulic engineer of the Department of Railways and Canals, have, by request, forwarded to the Ottawa Government a report upon all leaseholds of water power and rentals on the Welland canal.

The shareholders of the Hamilton, Grimsby and Beamsville Electric Railway Company last week ratified the action of the directors in abandoning the Vineland extension of the line. This consists of five miles of track, which has always been operated at a loss.

The ratepayers of Meaford, Ont., will vote on a by-law on the 16th inst. to raise $12,000 for the purchase of an electric light plant. The proposition is to take power from the local company to operate both the street lighting and waterworks. Advocates of the by-law figure out a considerable saving to the town by the scheme.

The ratepayers of St. Mary's, Ont., a short time ago voted down a by-law to borrow $15,000 for the improvement of the electric light and waterworks plants. The electric light plant is greatly overloaded and it is probable that the by-law may again be submitted in the hope that it will receive the approval of the citizens.

Messrs. Cope & Frey, of Vancouver, have secured the contract for wiring a number of the canneries at Steveston to which the B.C. Electric Railway Company will supply current. The contracts include the wiring of the Star, the Phoenix, the Brittannia, the Scotish Canadian and the Gulf of Georgia canneries.

The plant of the Sudbury Power Company, about two miles below the village of Wahnapitae, Ont., was started on Saturday, July 29th, and the formal opening will take place at an early date. The expenditure has been about $100,000. The town of Sudbury will be supplied with power to operate the electric light and waterworks systems.

The Town of Napanee, Ont., have passed a by-law to raise $35,000 for a new municipal lighting plant. The by-law has passed its third reading and the Council have retained the services of Mr. R. S. Kelsch, consulting engineer, Montreal, to design and install the plant. The plant will be designed and constructed so that the entire equipment will be duplicated to prevent the possibility of an interruption to the service in the event of emergency.

The Ontario Transmission Company, Limited, has recently been incorporated by the Ontario Government, with a capital of $1,000,000 and headquarters at Niagara Falls, Ont. The incorporators are Messrs. J. S. Lovell, Wm. Bain, E. W. McNeill, S. G. Crowell and W. F. Ralph, all of Toronto. The charter is a broad one and gives the company power to construct all necessary works for the production and transmission of electric and other power.

The remodelling and enlarging of the offices of the British Columbia Electric Railway Company, corner of Hastings and Carrall streets, Vancouver, B.C., have been completed. An additional story was built at the rear in order to provide adequate office room to meet the rapidly increasing needs of the company. The Vancouver Power Company and the Vancouver Gas Company also have offices in this building. A notable innovation is a demonstration room, where the various makes of gas stoves and ranges are shown in operation.

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SPARKS.

The ratepayers of Revelstoke, B.C., have approved of a $20,000 by-law for improvements to the electric light and waterworks plants.

The City Council of Charlottetown, P.E.I., have decided to renew the contract for five years with the Charlottetown Light & Power Company for lighting the city.

The Canadian Metal Company are canvassing the citizens of Frank, N.W.T., with a view of ascertaining what patronage might be expected for an electric light plant.

Mr. F. A. Cambridge, city electrician of Winnipeg, Man., is having a very busy season. At the present time no less than 40 permits a day are being issued by his department for electric wiring installations.

Mr. K. L. Aitken, C.E., of Toronto, has accepted the following tenders for an electric light plant for the town of Milton, Ont.: Boilers, smoke stack and engine, Waterous Engine Works Company, Brantford; generators, Allis-Chalmers-Bullock, Montreal.

The Concrete Pole Company, Limited, of St. Catharines, Ont., has recently been incorporated, to acquire patent rights from inventors for the manufacture and sale of concrete poles. The provisional directors are Messrs. H. M. L. Weller, of Toronto, and E. J. Odlum and H. H. Collier, of St. Catharines.

A charter has been granted to the Georgian Bay Milling & Power Company, Limited, of Meaford, Ont. The capital is $100,000, and the provisional directors are Messrs. William Moore, William T. Moore, T. R. Moore and W. J. Moore. It is proposed to acquire the business of William Moore & Sons.

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WESTERN ELECTRICAL ASSOCIATION.

The Vancouver electrical contractors have recently formed an association for the purpose of mutual benefit and protection. The unreasonable competition that has been prevalent there for some time back had resulted in the cutting of prices to such an extent that it was almost impossible to carry on an electrical business and make a living profit. The association, while not proposing to make prices exorbitant, aims to maintain a schedule rate at figures that will enable the contractors to do good work. Since the formation of the association they have succeeded in getting the rates for inspection down to about one-half the old rate. Dating from the first of July a license fee of $50 per annum will be imposed on all electrical contracting firms now doing business in the city and on all new firms that may start. This is aimed to prevent the practice of so-called electricians, competent or otherwise, from doing work on their own account at cut throat prices. Practically all the electrical shops in Vancouver are members of the association, which bids fair to hold firm and do much good. The president is Mr. F. C. Cope, vice-president Mr. A. F. Barber, and secretary-treasurer Mr. A. Cherrell.

The Canadian Westinghouse Company, Hamilton, have secured the contract for a new arc lighting system for the city of Niagara Falls, Ont.

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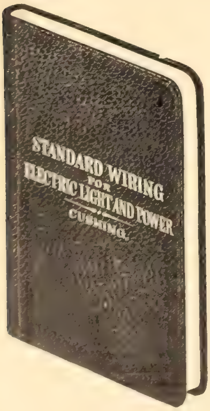

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SPARKS.

The ratepayers of St. Marys, Ont., sanctioned a by-law on August 7th to raise $15,000 for the extension of the water works and electric light systems.

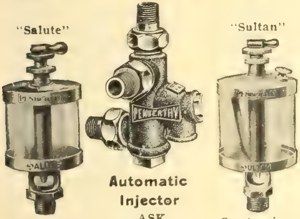
Mr. Charles Brandeis, consulting engineer, Montreal, has awarded the contract for an electric light plant for the town of Valleyfield, Que., to F. Savigny & Company, of that place. The work has already been commenced, and the contract calls for completion by November 1st next.

Mr. G. M. Gest, of Montreal, who makes the construction or conduit work a specialty, is just finishing a run of 34 ducts connecting the central station and the Lachine station of the Montreal Light, Heat & Power Company. He put in double manholes, four of them of concrete, the first of the kind and material in Montreal.

Attorney General Pugsley, of New Brunswick, recently had an interview in New York with the capitalists who are back of the proposed development of water power at Grand Falls, N. B. Their plans contemplate the harnessing of the power to the extent of at least 60,000 h. p., the intention being to supply Grand Falls and other towns along the St. John river with electric energy for lighting and power purposes. It is also proposed to acquire the Intercolonial railway between Campbellton and Grand Falls and to convert it into an electric road. The erection of pulp and paper mills is also spoken of. The expectation is to begin operations during the present year.

The Fessenden Wireless Telegraph Company of Canada have made application to the Dominion Goverment for incorporation. The promoters are Messrs. R. A. Fessenden, of Washington; E. W. Rathbun, Deseronto, and W. J. Gear, F. M. Cole and G. W. Stephens, of Montreal. The capital is fixed at $200-000. The Minister of Marine and Fisheries stated that the Government proposed to introduce a bill to regulate wireless telegraphy in Canada and to make it necessary to secure an order-in-council for each wireless station located. The company mentioned above asked for additional power to build land lines in case frozen ground interfered with wireless communication.

PENBERTHY



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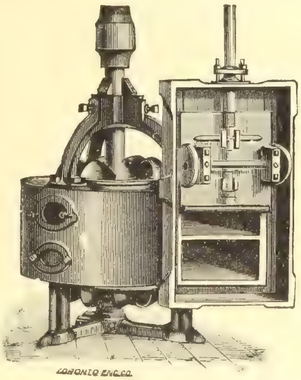
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SPARKS.

The lighting system at Edmonton, N.W.T., is being remodelled.

The Bell Telephone Company are reported to have purchased a site for their proposed new building at Brantford, Ont.

The town of Westmount, Que., is offering for sale $225,000 worth of bonds for the installation of an electric light and incinerator plant.

Within the past three years the number of incandesecent lamps in use in the town of Owen Sound, Ont., has increased from 1,500 to 7,276. The plant is now overloaded and early steps will be taken to enlarge it.

Mr. D. R. Young has announced the formation of a company to utilize the water power of Shuswap Falls, B.C., for an electric tramway to Lumby and for a light and power service to Vernon and neighboring cities. He claims that $150,000 of stock has already been subscribed.

The City of Ottawa, Ont., and the Consumers Electric Company have reached an agreement by which the company will receive $207,000 for their plant. The company originally asked $225,000 and the City offered $200,000, but to avoid delay and expense incidental to arbitration, it was agreed to compromise at the figure mentioned.

The town of Chatham, N. B., have decided to build a new municipal lighting plant. The present plant has been in existence 17 years, and is too small for the town's requirements. The new plant will, in all probability, be built with duplicate machinery, and the town have retained the services oi Mr. R. S. Kelsch, consulting engineer, Montreal.

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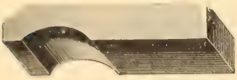

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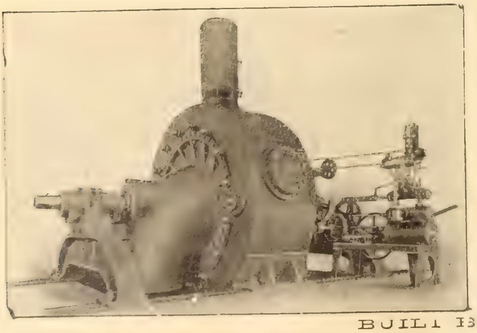

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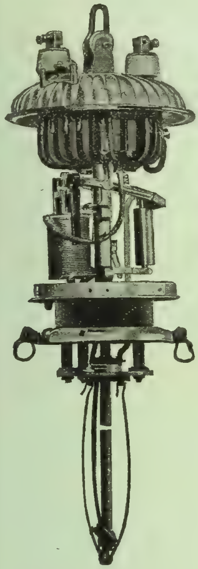
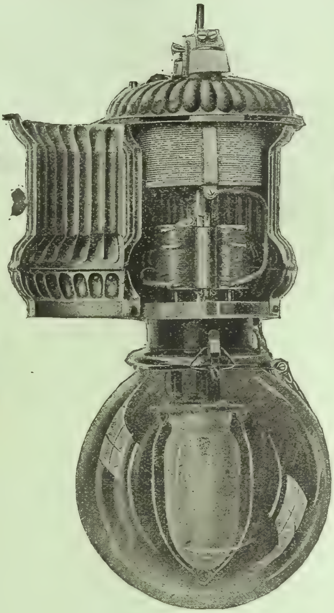
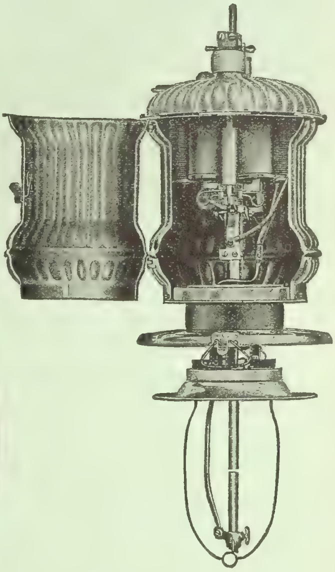


Mechanism of Multiple Alternating-Current Lamp



Multiple Direct-Current Lamp Showing Mechanism.



Mechanism of Series Alternating-Current Lamp

Some Features of the Three Leaders Follow:

Multiple A. C. Lamp

- Single Coil
- Phosphate Bronze Spring Mounting.
- 20 Coils on Reactive Device.
- Counterbalanced Armature.
- Insect-Proof.
- Adjustable for 3 Amperages.
- Fire-Proof : Uninjured by Short-Circuit.

Multiple D. C. Lamp

- Strictly Fire-Proof.
- Adjustable for 3 Amperages.
- Well Ventilated.
- Average Life : 150 Hours.
- Few Parts.
- Snap Hook on Globe Holder Chain.
- Unaffected by Short-Circuit.

Series A. C. Lamp

- No Iron Parts Exposed to Weather.
- Inner Reflector.
- Solid Copper Case.
- Substantial Construction.
- Non-Sticking Dash Pot.
- Cut-Out : Heavy Coin Silver.
- Insulation Unequalled.

No Moving Leads Attached to Lamp Switches

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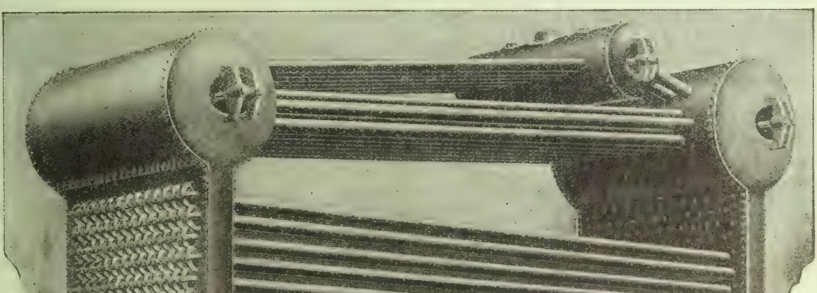

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TORONTO.

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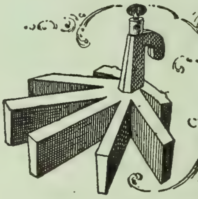

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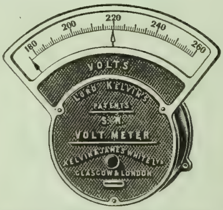

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Ammeters		Transmission
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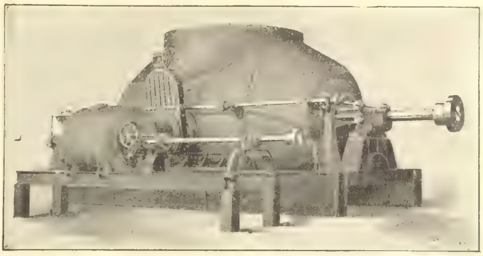

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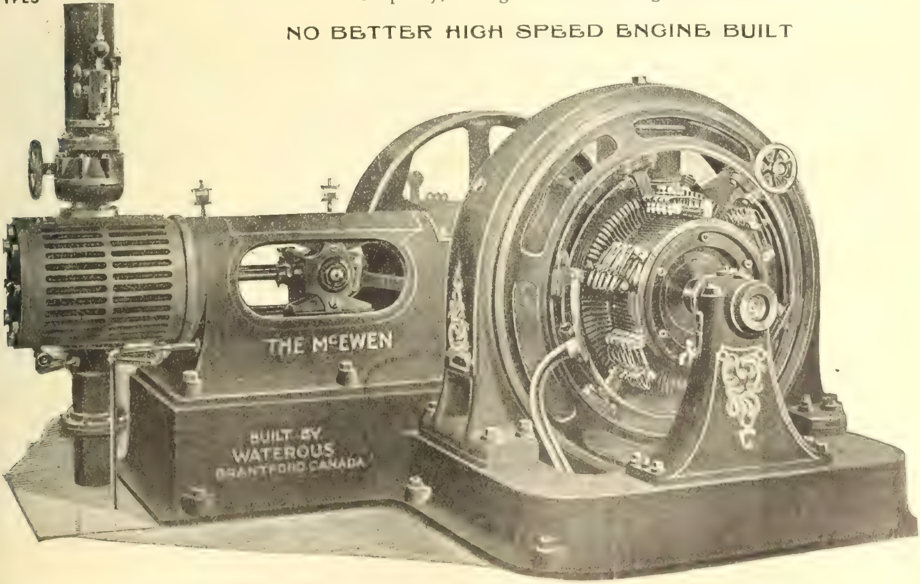

WATEROUS. BRANTFORD, CANADA

SPARKS.

The Electrical Supply Company, Limited, of Moncton, N.B., has recently been incorporated to manufacture electrical devices invented by Mr. Austin Berry, of Ottawa.

The Berlin Light Commission have accepted the tender of the R. D. Wood Company, of Philadelphia, for the installation of a 200 h.p. producer gas plant, the price to be $7,300 f.o.b. Philadelphia.

The St. Lawrence Supply Company, Limited, has been formed in Montreal, with a capital of $20,000, to manufacture machinery, electrical and steam devices, etc. Mr. M. H. Phelan, advocate, is one of the promoters.

The D. M. Steward Manufacturing Company, of Canada, Limited, recently organized, will manufacture electrical insulators, gas burners, etc. The head office is in Toronto, the provisional directors being Messrs. C. S. Steward, W. H. Frazier and S. L. Ezell.

The Power Company, Limited, has been incorporated at Hampton, N.B., with a capital stock of $20,000, to manufacture gas engines, etc. The promoters are Messrs. James E. March, C. J. Coster, J. P. Carritte and A. E. Emery, of St. John, and F. W. Wedderburn and R. A. March, of Hampton.

The City Electrician of Winnipeg, Man., has recommended that a new building be erected to relieve the overcrowded condition of the power house on McPhillips street. It is felt that step should be taken immediately, as in the near future the city will be receiving outside power and new apparatus will be required.

Messrs. A. Millar, G. Schmidt, A. Foster, sr., and J. A. Thibadeau, of Pembroke, Ont., have purchased from Mr. A. A. Rosseau a water power owned by him on the Black river near Waltham, Que. A new company, to be known as the Pembroke Electric Light & Power Company, has been formed to develop the power and to absorb the old Pembroke Electric Light Compan .

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has no equal for the facility it affords in business life.

Full particulars as to rates and service at the nearest office of the

BELL TELEPHONE COMPANY OF CANADA

GOOD BUSINESS OPPORTUNITY.

For sale.—Half interest in electrical fixture and supply company, $3,000 to $6,000 wanted to increase present business. Practical man preferred. Splendid showing. $10,000 worth of contracts in hand at present. Full investigation solicited.

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responsibility resting upon our manufacturers and power users in Canada is that in connection with their Steam Plants. The Boiler Room is the place where precaution is taken.

The largest Steam Users regard the assistance of a responsible Company a necessity in order to provide protection and to insure a safe and economical maintenance of their Steam Plants.

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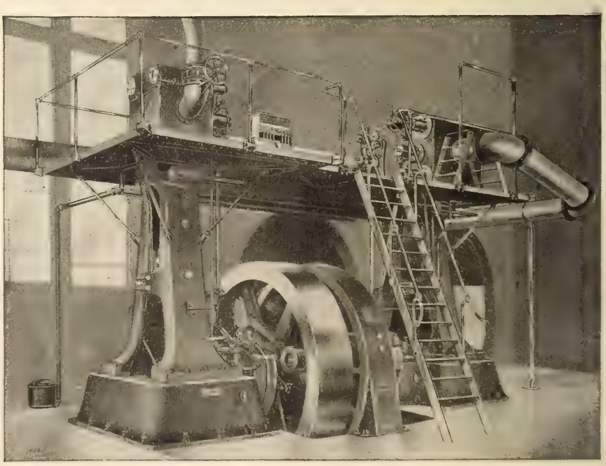
Simple, Tandem and Cross Compound



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SPARKS.

The Quebec Light and Power Company and the Jacques Cartier Electric Light Company, Quebec, have agreed to reduce the price of electric light per net kilowatt hour to 12 cents in summer and 10 cents in winter.

The Power & Gas Machine Company, Limited, was organized at Galt, Ont., last month, to manufacture gas and gasoline engines and devices for producing light, heat and power. The provisional directors are Messrs. W. H. Cone, F. E. Brown and William Foster.

Mr. Harry McLaughlin, one of the promoters of the Grand Falls Development & Power Company, which has secured a charter for the development of water power at Grand Falls, N. B., states that there is a possibility that operations will be commenced this year.

The local directors of the British Columbia Electric Railway Company will hold monthly meetings in the future for the purpose of discussing the business of the company and in order to keep the managing director, Mr. J. Buntzen, who is now residing in England, in closer touch with affairs.

The British Columbia Electric Railway Company are completing the work of replacing the old 40 lb. rails on their Vancouver-New Westminster interurban line with 60 lb. rails. Over 500 tons of rails are being used in this last part of the work, which is six miles on the Westminster end of the line. They are also double tracking the line for about a mile out from Vancouver city.

SETTLERS' LOW RATES WEST.

The Chicago and North Western Railway will sell low one way second class settlers tickets, daily from Sept. 15th to Oct. 31st, 1905, to points in Utah, Montana, Nevada, Idaho, Oregon, Washington, California and British Columbia. Rate from Toronto to Vancouver, Victoria, New Westminster, B. C., Seattle, Wash., or Portland, Ore., $42.25; to San Francisco or Los Angeles, Cal., $44.00. Correspondingly low rates from all points in Canada. Choice of routes. Best of service. For full particulars and folders write to B. H. Bennett, General Agent, 2 East King St., Toronto, Ont.

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¶ Water Wheel Plant consisting of pair of our 30 in. Crocker Turbines horizontally set in central discharge Steel Case. All complete with Draft Tube, Driving Pulley and Woodward Governor.

¶ We have this plant in stock ready for instant shipment.

¶ We invite enquiries and will promptly furnish complete information.

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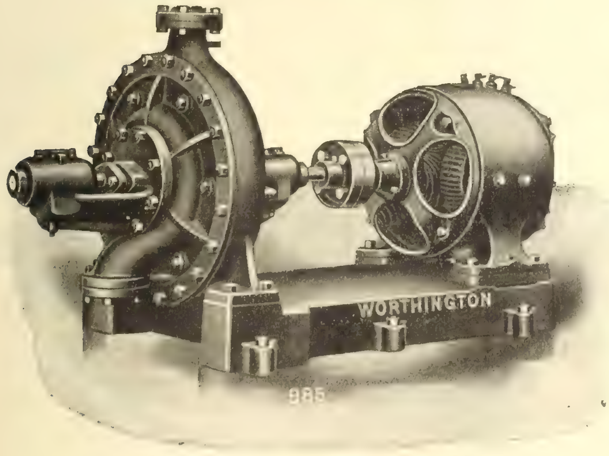

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All sizes and all pressures.
Prompt delivery.

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"Worthington" Pumps for Water Works and Mines.

Water Wheels

"Doble" Water Wheels for high heads.

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Sole Manufacturers in Canada for "Worthington" Turbine Pumps and "Doble" Water Wheels

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Philips Electrical Works, Eugene F. I
Wire & Cable Co.

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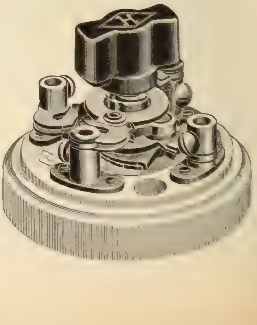
Hart Mfg. Coy.



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Rotary Standard Switches

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C. W. BONGARD & CO.,
Toronto, CANADA

PUBLICATIONS.

The Canada Foundry Company, Limited, Toronto, have issued Bulletin No. 32 descriptive of the Canada water tube boiler.

The Canadian Fairbanks Company, Limited, are sending out a hanger showing their new home at 44 St. James street, Montreal.

Recent publications from the Canadian Westinghouse Company, Hamilton, refer to the Westinghouse Type C. C. L. solid frame polyphase induction motors, regulating and reversing controllers, and Type B. intregating wattmeters.

Printed literature recently received from the R. E. T. Pringle Company, Montreal, refers to "Hubbell" full attatchment plugs and shade holders, Crown commutator compound, automatic switchless intercommunicating telephones, telephone cross arms, and other specialties which they manufacture or carry in stock.

The Murphy Iron Works, Toronto, manufacturers of automatic smokeless furnaces, set forth in a recent booklet many strong arguments in favor of the "Murphy" furnace, which has been in use in the United States for many years and is claimed to be giving excellent results. Among the users are the Cambria Steel Company, Johnstown, Pa., and the Pittsburg Railway Company.

The first number of The Engineering Journal of Canada has made its appearance, the publishers being Archibald W. Smith & Partners, Limited, Toronto. It is devoted largely to steam power and contains appropriate articles by Messrs. H. Gearing, A. M. Wickens, Charles Moseley, W. M. McKay and Jas. Bannon. The managing director is Mr. A. W. Smith, formerly advertising manager for Biggar-Samuel, Limited.

The McGraw Publishing Company, New York, have issued a book entitled "Wireless Telegraphy, its History, Theory and Practice", the author being A. Frederick Collins. A chapter is devoted to each of the following subjects: Ether; Wave Motion; Electric Waves; Disruptive Discharge; Electric Oscillations; Oscillators; Capacity, Inductance and Resistance; Mutual Induction; Induction Coils; Interrupters; Oscillating Current Generators; Electric Wave Action; Electric Wave Detectors; Transmitters; Receptors; Subsidiary Apparatus; Aerial Wires and Earths; Resonance; Syntonization; Wireless Telephony. The price of the book is three dollars.

The third edition of "Wireless Telegraphy and Hertzian Waves", by S. R. Bottone, has been published by Whittaker & Company, Paternoster Square, London, E. C. It explains in simple language the principles on which those phenomena known as "electric waves", "signalling through space without wires", etc., are dependent. No mathematical formulæ has been introduced. The subject is divided into four sections, viz: A brief outline of what electricity is; a short historical sketch; a description of the phenomena themselves; and lastly, constructional details of the various pieces of apparatus required.

TRADE NOTES.

Mr. J. M. Mackie, liquidator for the Laurie Engine Company, Montreal, will receive tenders up to September 20th for the purchase of the assets of the company.

The Hill Electric Switch Company, Montreal, have received an order for a complete switchboard from the A. D. Gall Petroleum & Chemical Company, Mont. Tremblant, Que.

The Jenckes Machine Company, of Sherbrooke, Que., have commenced work on their new factory buildings at St. Catharines, Ont., the contract having been awarded to Newman Bros.

The Hill Electric Switch Company, Limited, Montreal, are applying to Parliament for the necessary authority to issue $35,000 of additional stock, which action we understand is rendered necessary by the rapid increase of their business. They have recently moved into new quarters in order to considerably increase their plant.

Among the recent sales of Allis-Chalmers-Bullock, Limited, Montreal, are a mining outfit to the Canada Metal Company, Ainsworth, B. C., including one 15 h.p. vertical boiler, one 40 h. p. vertical boiler, two No. 5 Cameron sinker pumps, one 6¼ × 8″ hoisting engine, one 7 × 10″ hoisting engine, ore buckets, etc., and to the Souris Coal Mining Company, of Bienfait, Assa., one 75 h.p. Lidgerwood hoisting engine of the combined friction drum and brake and reversible link motion type.

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SPARKS.

Messrs. Hutchison Bros., electrical engineers, recently opened up an establishment on Broughton street, Victoria, B.C. They manufacture and install motors and other electrical machinery.

We are advised that the Canadian Westinghouse Company have closed a contract with the West Kootenay Power and Light Company, of Rossland, B.C., to supply all the transformers for their new system. At the main station at Bonnington Falls, six 1,875 k.w. raising transformers, 2,200 volts to 6,000 volts, will be installed, also three 1,250 k.w. interconnecting transformers, 2,200 volts to 22,000 volts; three regulating transformers and one polyphase regulator, used in connection with the interconnecting transformers. The various sub-stations of the West Kootenay Company will have the following equipment: Sub-station No. 1, at Grand Forks, six 1,250 k.w. step-down transformers, 60,000 volts to 440 volts; sub-station No. 2, at Phœnix, three 1,250 k.w. step-down transformers, 60,000 volts to 2,200 volts; sub-station No. 3, at Greenwood, three 1,250 k.w. step-down transformers, 60,000 volts to 2,200 volts. These will all be oil insulated water cooled transformers for 3-phase circuits.

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SPARKS.

The Westinghouse interests are reported to have purchased a site on the Niagara frontier on which to build a factory for the manufacture of electrical machinery. The Ontario Power Company is said to be associated with the Westinghouse people.

Mr. Bruce Cann was instantly killed at Glace Bay, N.S., on August 17th by coming in contact with a live wire. It transpired at the inquest that the current at the power house had been turned on by some person unknown.

Mr. Ormond Higman, chief electrical engineer of the Inland Revenue Department, Ottawa, has installed electrical standards at Vancouver for the purpose of testing meters. It is also the intention to open an electric meter testing branch at Edmonton, N.W.T.

To meet the rapidly increasing demand for current, a new 300 kilowatt generator will shortly be installed in the power house at Bracebridge, Ont. Current to the extent of nearly 200 h.p. is now being furnished to operate electric motors, and the Beardmore Tanning Co. is arranging to install motors of 75 h.p. capacity.

The West India Electric Company, in which Canadians are largely interested, have acquired the Jamaica Electric Light & Power Company and have thus secured the entire control of the tramway and lighting business of Kingston, Jamaica. Mr. Hutchison, the president, states that he believes the future prospects of the company to be exceedingly bright.

Vancouver's new electric wiring by-law went into effect on the 1st of August. The by-law is the outcome of considerable agitation on the part of the electrical contractors of the city to have the cost of inspection reduced. Formerly the inspection of wiring, where there were six lights or under, cost one dollar, and 15 cents extra for each light up to ten. The cost now is one dollar for ten lights or under, ten cents extra for each light over ten and up to twenty, while over twenty the cost is only five cents per light. The cost of inspecting arc lights has also been reduced from 25 to 15 cents.

Within the past month it has been reported that the directors of the Canadian Pacific Railway are considering the adoption of electric power for the operation of their road between Fort William and Winnipeg. It is said that estimates on the cost of the scheme will be made in the near future. It is believed that an abundant supply of power could be obtained by developing the Kakabeka falls for the operation of the easterly section and by utilizing the power of the Winnipeg river for the operation of the western section. There is also a power site at Keewatin where probably 30,000 horse power could be developed.

MOONLIGHT SCHEDULE FOR OCTOBER.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Oct. 1	6 10	Oct. 2	5 20	11 10
2	6 10	3	5 20	11 10
3	6 10	4	5 20	11 10
4	6 10	5	5 20	11 10
5	9 50	6	5 20	7 30
6	10 50	7	5 20	6 30
7	11 50	8	5 20	5 30
9	0 50	9	5 20	4 30
10	1 45	10	5 20	3 35
11	2 40	11	5 30	2 50
12	No Light	12	No Light	
13	" "	13	" "	
14	5 50	14	7 50	2 00
15	5 50	15	8 30	2 40
16	5 50	16	9 00	3 10
17	5 40	17	9 40	4 00
18	5 40	18	10 20	4 40
19	5 40	19	11 10	5 30
20	5 40	21	0 00	6 20
21	5 40	22	1 00	7 20
22	5 40	23	2 10	8 30
23	5 40	24	3 10	9 30
24	5 40	25	4 20	10 40
25	5 30	26	5 30	12 00
26	5 30	27	5 40	12 10
27	5 30	28	5 40	12 10
28	5 30	29	5 40	12 10
29	5 30	30	5 50	12 20
30	5 30	31	5 50	12 20
31	5 30	Nov. 1	5 50	12 20
		Total	....	224 55

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PERSONAL.

Prof. Samuel W. Perrott, Bachelor of Arts and Engineering of Trinity College, Dublin, has been appointed Dean of the Engineering School of the University of New Brunswick.

Messrs. Thomas Ahearn, W. Y. Soper and George F. MacDonald, of Ottawa, attended the convention of the Old Time Telegraphers' Association held in New York last month.

Mr. F. A. Cambridge, City Electrician of Winnipeg, was a visitor to Toronto during the Exhibition, having been in attendance at the Convention of Municipal Electricians at Erie, Pa.

Mr. William G. Angus, electrician for the Hamilton Cataract Power, Light & Traction Company, has been appointed manager of the Lincoln Light & Power Company, St. Catharines, which was recently acquired by the Cataract Power Company.

Messrs. J. G. White & Company, New York, announce that they have secured for assistant mechanical engineer Mr. William N. Stevens, who resigns from the Interborough Rapid Transit Company.

Mr. F. J. Parkin, who has been on the staff of the Canadian General Electric Company at Toronto, has recently been appointed one of the Company's representatives in the Northwest, with headquarters at Winnipeg.

Mr. C. E. A. Carr, manager of the London Street Railway, has tendered his resignation. It is understood that he has been engaged by the Everett-Moore syndicate to manage one of the large electric roads in the United States.

Mr. C. F. Flinn, of Chicago, who is now on a business trip in Western Canada, was a recent caller at the Winnipeg office of the ELECTRICAL NEWS. Mr. Flinn represents the Westinghouse Machine Company, of East Pittsburg, Pa.

Mr. Fred W. Scott, of Toronto, is now engaged upon the construction of the steel towers for the transmission of electric power from Lac du Bonnet to Winnipeg, which undertaking is being carried out by the Winnipeg General Power Company.

Mr. Ney, who for three years past has been assistant to Mr. Simmons, superintendent of the electric light and power station at Bracebridge, Ont., has recently accepted a position in the Lachine station of the Montreal Light, Heat & Power Company.

The sudden death, from heart failure, of Mr. G. H. Hawkins-Emett, of New Westminster, B. C., occurred at Victoria on August 14th. The late Mr. Emett, who was a mechanical engineer by profession, recently became prominent on the Pacific Coast as the inventor of "Emett's Hardite". He was about 40 years of age.

Mr. J. M. Robinson, who recently retired from the position of managing director of the St. John Street Railway, was made the recipient of a handsome silver punch bowl by the directors and shareholders of the company in recognition of his services. Mr. Robinson replied briefly, expressing his thanks and appreciation of the handsome gift.

In view of the resignation of Mr. K. B. Thornton as superintendent of lines for the Montreal Light, Heat & Power Company, Mr. R. M. Wilson, superintendent of stations, has been appointed general superintendent of the electrical department, and Mr. W. B. Kelsch, superintendent of construction, becomes assistant superintendent of lines.

Mr. Haden Bales, late electrician on the steamer Empress of Japan, was entertained at dinner at Vancouver by some of his late shipmates, during which he was presented with a gold chain and pendant as a token of esteem. After fourteen years' continuous service on the Empress of Japan, Mr. Bales is leaving the sea for the more settled life of the land.

The electrical industry of Canada has sustained no small loss by the removal of Mr. K. B. Thornton to New York. Mr. Thornton graduated from the Central Technical College, South Kensington, London, England, thirteen years ago, and has ever since been identified with electrical matters in Montreal. He was first connected with the Royal Electric Company, and upon the merging of the Montreal lighting interests was appointed superintendent of lines for the Montreal Light, Heat & Power Company, which position he has resigned to associate himself with Mr. P. G. Gossler, the second vice-president of J. G. White & Company, electrical engineers and contractors, New York. Mr. Thornton's work in the interest of the Canadian Electrical Association, of which he was president last year, was of great value, and his retirement from active connection with the Association is much regretted. He was held in high esteem by the officers of the Montreal Light, Heat & Power Company, as attested by the presentation to him of a loving cup. Mr. Thornton carries with him the best wishes of many Canadian friends.

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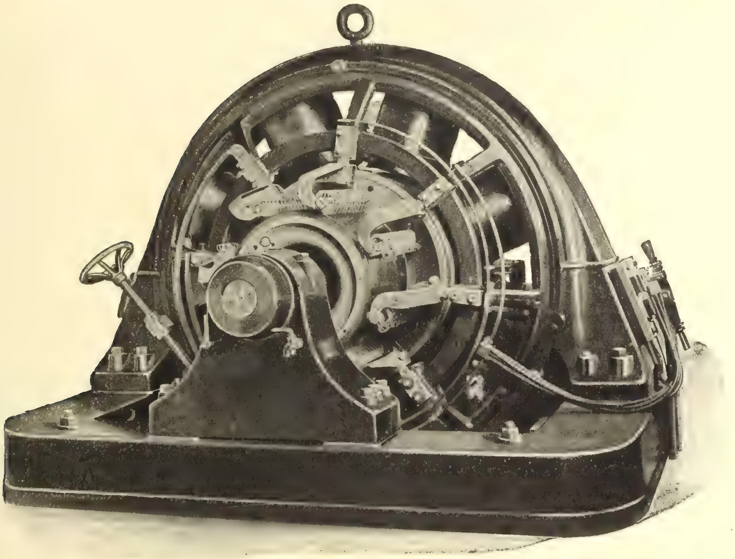

One of the 800 k. w. ROTARY CONVERTERS we built for the Shawinigan Water and Power Co. in operation a their Montreal sub-station. We are now building that company a third machine of the same size. For description of construction and operation see Bulletin 1031.

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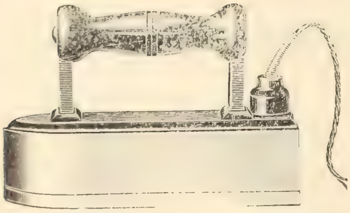

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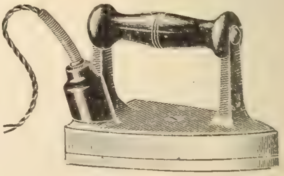

CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XV. SEPTEMBER, 1905 No. 9.

The Clyde Valley Electrical Power Company, Glasgow, Scotland

Through the kind co-operation of Mr. D. A. Starr, the general manager of the Clyde Valley Electrical Power Company, Glasgow, Scotland, we are permitted to publish in this number a description, accompanied by illustrations, of the two generating stations which that company have recently completed, one being at Yoker, the other at Motherwell.

For many years the Clyde and the neighboring district has been famed as a center of high industrial and engineering importance, and it is the avowed object of the Clyde Valley Electrical Power Company to help manufacturers in the district surrounding Glasgow to maintain the position they have so long held, and to aid them in competing as keenly as ever in the world's markets.

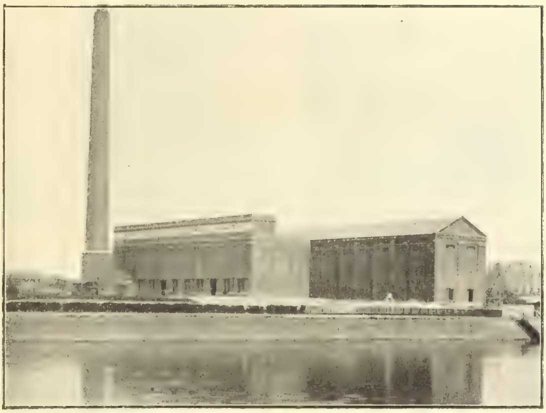

FIG. 1. YOKER POWER HOUSE.

The company, which was incorporated in 1901, has obtained powers over an area extending along the Clyde Valley from Craigendoran and Port Glasgow on the west to Lanark and Shotts on the east. This area, which comprises about 750 square miles, contains the most important manufacturing and coal producing district in Scotland.

Land was acquired for the erection of generating stations at Yoker and Motherwell, 5 miles and 15 miles out of Glasgow respectively; and in September, 1902, a contract was entered into with the British Westinghouse Electric & Manufacturing Company for the erection and equipment of these two stations and the various sub-stations that are dotted over the area.

Situated on the banks of the Clyde, where an unfailing supply of water for condensing purposes is available, is the Yoker generating station, shown in Fig. 1. The Motherwell station being situated at a higher elevation, and above the level of the River Clyde, depends for its water supply for condensing purposes on electric pumps working against a head of 140 feet.

The main engine room measures 252 feet long by 43 feet wide. Its walls are faced with white glazed bricks for the sake of cleanliness in order to give the maximum of light, and the floor throughout is of Terravio paving.

Part of the south end of the engine room is occupied by the offices, which are placed adjacent to the switchboard galleries. Accommodation is provided here for the station superintendent, storekeepers and timekeepers. The offices are divided from the switch galleries by iron doors, and everything is of a thoroughly fireproof construction, special attention having been paid to this important matter.

THE BOILER HOUSE.

The boiler room has an inside measurement of 186 feet long by 50 feet wide. It is well lighted by side windows, and in every way is designed to afford the maximum of convenience. Over it are placed the coal bunkers, and at the north end is the chimney. This is built on the Alphonse Custodis system, of special perforated and moulded bricks, and is of the following dimensions: Height above foundations, 225 feet; inside diameter at the bottom, 14 feet; inside diameter at the top, 11 feet. It is lined with firebricks up to a height of 85 feet above the top of the foundation, which extends to a depth in the ground of 22 feet. The base of the foundation occupies a space of 2,116 square feet, and the weight divided over the entire area is two tons per square foot, allowance being made for wind pressure.

The coaling arrangements are most complete, and from start to finish the fuel is untouched by hand. Coal is brought in wagons to the company's private siding, and, after being dumped by a hydraulic ram into the crusher pit it passes through a crusher and screen operated by a motor; it is then picked up by the conveyor buckets and carried to the storage bunkers over the boiler house; from here it passes automatically to the boilers, being weighed—also automatically—in transit, the number of cwts. used being recorded on an indicator. The conveyor was constructed by Messrs. Graham, Morton & Company, and is motor-driven. The same conveyor is also used for carrying the ashes away from the boiler house.

To prevent the coal sticking in the shoots a motor-operated agitator is installed, which keeps it constantly on the move.

There are installed at present four double-drum Babcock & Wilcox water-tube boilers, fitted with superheaters capable of imparting 136 degrees F. of superheat. The steam pressure at which they work is 165 lbs. per square inch. Each boiler is equipped with a Roney mechanical stoker manufactured by the British Westinghouse Company, and these are driven through special worm gearing by two Westinghouse standard engines situated at the side of the boilers. The boilers are connected to a main flue passing along the back, and a Green's economiser of two sections and 480 tubes is installed between this flue and the chimney. The economiser is provided with a bye-pass flue, which ensures convenience and safety in operation.

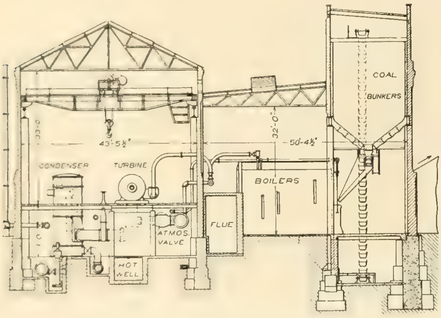

Fig. 2.—Sectional Elevation of Yoker Power House.

Two boiler feed pumps of Messrs. J. P. Hall & Sons' make are situated in the basement. Each is of the tandem compound, double-acting type, and capable of delivering 9,600 gallons per hour against a boiler pressure of 175 lbs. per square inch.

The feed water is taken from the hot well, to which it is pumped from the condensers by a centrifugal pump driven by a vertical shaft motor. The make-up water is taken from the city mains; there is, however, a stand-by suction from the river.

THE GENERATING ROOM.

The engine room consists of two floors, all the auxiliaries being in the basement with the exception of the exciters.

The main generating plant as at present installed in the Yoker station consists of two Westinghouse-Parsons steam turbines (Fig. 3), each with a normal capacity of 3,000 h. p. and an overload capacity of 3,750 h. p. These turbines run at a speed of 1,500 revolutions per minute.

The turbines are of the latest double-flow pattern, steam entering at the centre and exhausting at both ends. Each set exhausts directly into its own surface condenser, which is of the vertical type, manufactured by the Mirrlees Watson Company of Glasgow, and provided with steam-driven two-stage dry air pumps situated in the basement. Arrangements have also been made for exhausting to atmosphere if necessary. The circulating water for the condensers is drawn from the River Clyde, running by gravity into a large circular well, 18 feet in diameter and of a depth below low water level of 9 feet.

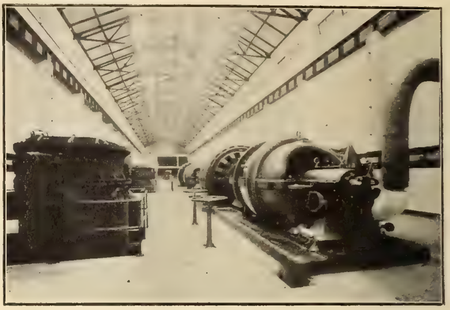

Fig. 3.—General View of Engine Room.

There are two pipes leading into the well, each of 30 inches diameter, and the water is drawn out through a 36-inch cast iron pipe by means of a steam-driven centrifugal pump situated in the basement. After passing through the condensers the water is discharged by a 36-inch pipe into a spill-way on the bank of the river.

The oiling system for the turbines is arranged as follows: A large tank in the basement of the engine room is filled with a supply of oil which should las from one to two years. This is raised by a special oil pump to a tank in the roof of the boiler house, and from thence flows by gravity under a head of 50 feet to the bearings. Pressure gauges on the latter indicate that the oil is circulating properly.

Each of the above turbines is directly connected to a Westinghouse 3,000 h.p. generator, which generates electric current at a pressure of 11,000 volts, three-phase, at 25 periods per second. This is the pressure at which current is distributed to the various sub-stations.

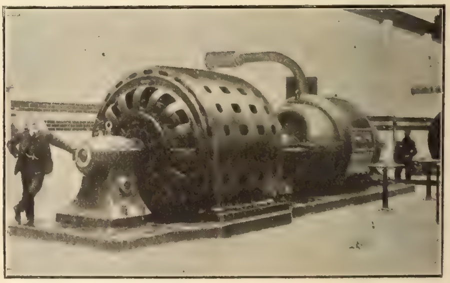

Fig. 4.—3,000 H. P. Turbo-Generator.

The engine room as at present constructed will accommodate one more unit of 2,000 k.w. and one of 3,500 k.w., which will make the total capacity of the station 9,500 k. w. or 13,000 h.p. These additional sets will be added as soon as the load on the station increases, so that there will be always one set spare and ready at any moment in case of accident.

The two exciter sets situated at the south end of the engine room are each capable of furnishing all the exciting current for both the main generating units at present installed. They are of 75 k. w. capacity each, and consist of a Westinghouse vertical compound engine, running at 290 revolutions per minute, coupled direct to a compound wound dynamo generating direct current at a pressure of 125 volts. These two engines have their separate condenser, which is of the Worthington Company's make and has 600 square feet of cooling surface. They are situated, with the other auxiliary machinery, in the basement.

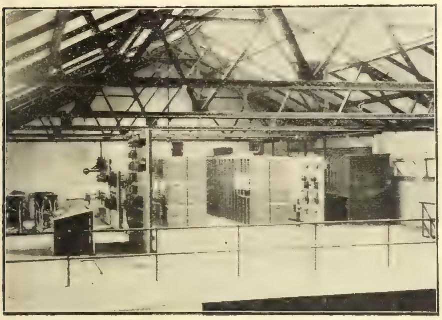

Fig. 5.—Upper Switchboard Gallery.

The exciters also supply current to operate the motors of the coal and ash conveyor, crushers, agitators, economisers, and pumps; also for the electrically-operated main switches, which will be described later.

THE SWITCHBOARDS.

The complete switching apparatus for controlling the whole of the plant in the power house, and also the cables which run to the sub-stations, is situated at the south end of the engine house, and is distributed over four floors. In the basement the outgoing cables are connected to the terminals of the switchboard, and here also are the protective devices against undue rises of pressure.

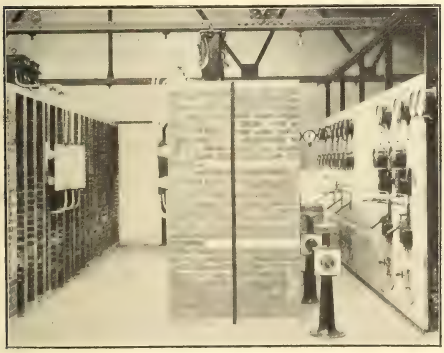

Fig. 6.—Part of Top Gallery, Showing Motor Generator Control Switch and Bus-Bar Crucibles.

On the first floor, at engine room level, are placed the switches controlling the outgoing cables, and also the main generator switches.

On the first gallery will be seen two rows of switches, which allow either the generators or outgoing cables to be connected on to either one of the duplicate set bus bars, thus ensuring continuity of supply at all times. On this gallery are two motor generators, each of 150 k. w. capacity; these are intended to supply current at 3,000 volts, 50 periods, three-phase, to the Clydebank district. The motors of these sets take 25 period 11,000 volt current from the main sets without the interposition of transformers, and are direct-connected to the generators, which work at 3,000 volts, 50 periods. Each set is provided with a small motor coupled to the shaft, which serves for starting them and running up to speed.

On the second or top gallery are placed the main bus bars and the main controlling board, as well as the resistances, etc. (Fig. 6). The control board consists of a small desk directly facing the various instruments, such as ammeters, voltmeters, power factor meters, indicators, relays, etc. All the main switches and smaller gear are electrically operated from this desk by the exciter current as before mentioned, and the speed of the turbo-generators and their starting and stopping is also controlled from here. The operation of the engine room is thus practically centralized in one spot, which besides offering a maximum of convenience in working, reduces the chances of breakdown to a minimum.

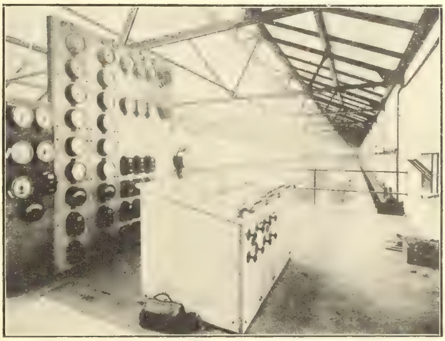

Fig. 7.—Indicating Instruments, Time-Limit Relay Switches, Etc.

On the third gallery is also situated the switchboard for the distribution of the 3,000 volt current to the Clydebank area.

THE MOTHERWELL STATION.

Both the Yoker and Motherwell power stations are of the same size and almost identical in arrangement; the foregoing description therefore applies generally to both, with the following exceptions:

As to the Motherwell station, it is not so favorably placed as the Yoker, being 400 yards from and 140 feet above the level of the river. A cooling tower of Messrs. Balcke & Co.'s make has therefore been installed for cooling the circulating water. It is of the natural draught enclosed type, 73 feet high, and is constructed entirely of wood thoroughly soaked in carbolineum of the best quality. The tower has a normal capacity for cooling 220,000 gallons of water an hour from 120 degrees F. to 80 degrees F., when the temperature of the air is 70 degrees F. or less; and the amount evaporated under ordinary conditions of atmospheric temperature does not exceed 2½ per cent. of the water circulated.

Another of the features in which the Motherwell station differs from the Yoker is in the condensing plant, a barometric jet condenser being installed. This is capable of giving a vacuum of 27.5 inches when dealing continuously with 80,000 pounds of exhaust steam an hour, if supplied with 348,000 gallons of circulating water an hour at a temperature of 80 degrees F.

In connection with this condenser there are installed at Motherwell two Alberger-Corliss, two-stage, dry vacuum pumps, 10 and 24 by 24-inch, one of which is capable of dealing satisfactorily with the air in the condenser when one turbine only is in operation. Their normal speed is 100 revolutions a minute, but they are capable of working at a lower rate if necessary. The steam and exhaust valves are of the Corliss type, and so designed as to permit of a high speed in case of emergency without noise or jar.

DISTRIBUTION.

Six feeders are provided for distribution from Yoker, and all are protected when they enter the building in the basement by Westinghouse lightning arresters. They are all laid in duplicate, so that in case of any accident happening to one of them, the spare one can be connected immediately while the duplicate is being repaired. Energy will be supplied on the three-phase alternating current system.

At present the number of substations installed in the layout of the scheme is ten for the Motherwell district and two for the Yoker. These two districts will not at present be connected in any way, although they may be in the future.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ENGINEERS.

A very successful meeting of the I. A. M. E. was held at Erie, Pa., on August 23rd, 24th and 25th, it being the annual convention of the association. A paper was read on "Suggested Improvements in Fire Alarm Telegraph Systems", by Capt. Brophy. The author reiterated the need of better methods of line construction and greater care in selection of both ærial and underground material and threw out a suggestion as to the advisability in very large cities of providing more than one fire alarm office, tied together, however, to one central office so that in case of disablement of any one office the others could look after the service of the remaining districts and complete service be established sooner than by simply having one central office.

A valuable paper on "Underground Construction", by Louis Gascoyne, Detroit, brought out among other points the fact that very good results have been attained in that city by the use of plain iron pipe as a conduit. The pipe is specially treated, being reamed and smoothed inside, heated over a coke fire and dipped in a bath of tar and linseed oil and placed on end to remove surplus tar. Pipe treated in this way is said to be rust proof and has stood for a number of years without deterioation.

A paper on the "Maintenance and Operation of Municipal Electric Light Plants", by A. S. Hatch of Detroit, for some years closely identified with the municipal plant of that city, laid special emphasis on the necessity of maintenance and of the necessity of exercising good judgment in the matter of discarding machinery of various kinds. The discussion on the paper referred to the too frequent interference of political wirepullers with the service to the detriment of the latter. It was also stated by Mr. Hatch that the success obtained in Detroit would not have materialized had the city undertaken a domestic and commercial service as well as a purely municipal one. The social side was well looked after by an energetic local committee, visits to points of interest being made and some of the large manufacturing establishments looked over.

A good exhibit of fire alarm and police telegraph apparatus was shown at the convention headquarters.

While there was a good representation from American cities, but three Canadian cities had representatives, viz: Toronto, Ottawa and Winnipeg. It is well worth the while of any Canadian offcial having charge of municipal electrical departments to join the Association and participate in its advantages.

STEAM ENGINEERS' CONVENTION.

The ninth annual convention of the International Union of Steam Engineers, held in Toronto September 11 to 15, was attended by delegates from all over Canada and the United States. An interesting program was carried out. A number of prominent Canadian and American manufacturers took occasion to exhibit their up-to-date appliances in the line of engineers' and steam users' supplies, including the following:

Canadian Fairbanks Company, Montreal—Engineers' supplies.

Canadian Oil Company, Toronto.

Babcock & Wilcox, Montreal—Boilers and superheaters.

Economical Supply Company, Toronto—Engineers' supplies.

Gentle & Travis, Toronto—Steam traps.

Garlock Packing Company, Hamilton—Engine packing, etc.

Queen City Oil Company, Toronto—Oils and lubricants.

Crandell Packing Company, Palmyra, N.Y.—Engine packings.

Greene, Tweed & Company, New York—Engine packings.

International Correspondence Schools, Scranton, Pa.

The Lukenheimer Company, Cincinnatti—Lubricators and oiling devices.

Dearborn Drug and Chemical Company, Chicago—Lubricants.

McLeod & Henry Company, Troy, N. Y.—Furnace linings, firebrick, etc.

Norwall Mfg. Company, New York—Valves.

Jenkins Bros., New York—Valves and packings.

Jordan Bros., New York—Commutator devices.

New York Belting & Packing Company, New York—Packings.

Peerless Rubber Company, New York—Packings.

United States Graphite Company, Saginaw, Mich.—Lubricants.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Ques. No. 1.—I have been making some tests on the amount of coal we are burning in our electric light plant here, and find that we use about fifteen pounds on the average per kilowatt hour. Do you think this is too high? We have a high speed engine of about 100 horse-power belted to a direct current dynamo.

Ans.—We presume that your engine is of the simple non-condensing type and that you are carrying a boiler pressure in the neighborhood of about eighty pounds per square inch. Under ordinary electrical plant conditions, where no heating is done, and the load factor is poor, a coal consumption of fifteen pounds per kilowatt hour may often be found. In some plants of about your size, we have known the coal consumption to be almost double the amount stated, while on the other hand, where a compound corliss condensing engine has been used, and where the load is fairly large and steady, a consumption of under eight pounds has been obtained. It is very difficult for us to say whether your fifteen pounds is higher or lower than would be expected, as a conclusion can be arrived at only after a careful study of all the local conditions. Where a tubular boiler is perfectly clean, and firing is carefully done, an evaporation of nine pounds of water per pound of good fuel may be obtained, but under average working conditions we should say that six pounds of water per pound of fuel is a fairly good showing. Thirty-six pounds of steam per indicated horse-power per hour would be fair for an engine of the size and type that you have installed. This means a fuel consumption of six pounds of coal per indicated horse-power hour. Adding 25 per cent. to cover friction loss in the engine and belt and the loss in the generator, and multiplying by 1.34 to get the readings to a kilowatt-hour basis, we find that the coal consumption per kilowatt-hour is approximately ten pounds. These figures are for continuous operation, and if you are running your plant at its full rated capacity, you would probably obtain a consumption very close to ten pounds. However, such conditions of operation practically never occur, and as your load factor drops, your pounds of coal will increase. With a consumption of fifteen pounds we do not think that you are very badly off, and would suggest as a remedy that you increase the amount of your load and in so doing make every possible effort to improve the load factor.

Ques. No. 2.—Will you tell me how the cylinders are proportioned in compound engines?

Ans.—In a cross compound engine the cylinders are so proportioned as to produce the same power on each crank, but this is not always done in tandem compound engines. One of the rules which may be followed is that if P be the gauge pressure in pounds per square inch, then

$$\frac{\text{Area of low pressure cylinder}}{\text{Area of high pressure cylinder}} = \frac{4P+40}{100}$$

This means that with a steam pressure of ninety pounds the low pressure piston should have four times the area of the high pressure. Some of our standarad manufacturers use a ratio of 4 to 1 or 7 to 2. In a triple expansion engine using 120 pounds initial pressure, a ratio of five, two and one-half and one, is often used, while with pressure of 160 pounds a ratio of eight, three, and one has often been adopted.

Ques. No. 3.—The other day I was called down to look at the lights on a large fixture in one of our churches, some of the lights burning dull while others burned bright. The fixture contains 28 lamps and is fed from a three wire circuit; 14 lamps being on each side of the system and each side being controlled by a separate switch. The line was originally a two wire line and was later changed to three wire. Do you think the line is out of balance, or what is the trouble?

Ans.—We would think that the trouble in this fixture is caused by a simple mistake in connection, rather than any unbalanced condition of the circuit, and would suggest that the following tests be made to ascertain the source of the difficulty. With a voltmeter or test lamp, test the voltage between the neutral and the two outsides as near the fixture as possible, with all lamps turned off and then with all turned on. If you get full voltage on the meter or full brilliancy on the lamp with both tests, this will show that your lines leading to the fixture are O.K. If you do not, this will indicate that the trouble is between the point of test and some point on the street lines. If you get full voltage then you will probably find the difficulty in the fixture itself, and this is where in all probability you will locate the trouble. Turn the dull lamps out one by one by the keys in the sockets, or if the sockets are keyless, by unscrewing the lamps. You will probably find that some of the dull lamps will get brighter and some will get duller; also that when about half the lamps are out, the turning out of one more lamp will put all the rest out. This will indicate that the dull lamps have a series connection somewhere. The lamps should all be connected between the neutral and one of the outsides, and if you examine the wiring of the fixture carefully you will doubtless find that this is not the case. We would suggest that you try the above tests at once and let us hear from you further. The turning out test might be tried first, as this, we think, will immediately locate the trouble as being in a connection of the fixture.

Ques. No. 4.—We have trouble with some of our incandescent lamps getting dull very rapidly. What is the cause of this?

Ans.—As soon as an incandescent lamp is put in service it almost immediately commences to lose its full candle-power. This loss, however, in a good lamp used on a steady and proper voltage, is almost unnoticeable, and at the end of six hundred hours the brilliancy should not have decreased more than 20 per cent. Rapid loss of candle power may be due to a fault in manufacture, or to the fact that the lamp is used either on a voltage other than that for which it is intended or on a circuit in which the potential is subject to severe fluctuations. If the trouble is with the lamps, then the remedy is to purchase from some other manufacturer, but if the difficulty is caused by unsteady voltage then the remedy is apparent. Bear in mind that the best lamps made will depreciate rapidly if the pressure is not maintained steady. You will probably have trouble also in the blackening of the bulbs. This will happen in good lamps as well as in poor ones, but in the former case the trouble will be due to excessive voltage or that the lamps are being burned beyond the point of their useful life. In this case the remedy is, of course, regulation of pressure, and frequent renewals.

AN INCREASED RESERVE PLANT.

The Ottawa Electric Company, finding that the various water power owners at the Chaudiere Falls cannot get together and agree to make improvements to hydraulic works that would benefit all by an increased water supply during the period of shortage in the winter, is about to take the matter into its own hands to the extent of making sure of getting at any rate its full share of the water, all that it is entitled to. With that object in view works of considerable importance have been under consideration and in the meantime in order to prevent all possibility of impaired service owing to the carrying out of works of improvement, shortage of water, anchor ice, etc., it has decided to install at once a steam reserve plant of considerable capacity, in addition to the steam plant already owned and operated by this company as an emergency plant. The installation will be made at once and the plant is to be in operation in four months. It will consist of a Westinghouse-Parsons steam turbine direct-connected to a two phase A.C. generator of 1500 kilowatts, this unit to be placed in the present engine room, where there is all necessary space without disturbing the present plant.

There will be a condensing plant of the latest and best design. A new boiler room will be built using the old chimney, which is 125 feet high and has sufficient capacity to acccommodate the new plant. The boiler plant will consist of probably two batteries of high grade water tube boilers. The boiler capacity will be sufficient to operate the turbine and generator to the highest limit of allowable overload when desired. There will also be some arrangements for coal handling, but the firing will be done by hand.

The exciter will be mounted on a bracket and on the turbine frame and direct connected to the turbine shaft, and there will be other sources of current for exciting the field, which will be available at any time in case of failure of the exciter.

The switchboard will consist of the apparatus usually furnished on a generator panel, including an integrating wattmeter and a power factor indicator. The leads from this board will run into the main station a few hundred yards away, where they will connect to busbars, that being the distributing as well as the main generating station.

The work will be pushed with vigour and this plant will place the Ottawa Company in a practically independent position as regards fluctuations of water supply.

EXPORTS OF ELECTRICAL APPARATUS.

For the 12 months ended June the 30th, 1905, the total electrical exports from the United States reached a value of $12,253,904. This compares with $10,507,013 for the corresponding period ended in 1904, and $9,986,076 for that ended in 1903. The most noticeable gain in the export of electrical machinery to any one country during the year ended with June is that to Japan, whose imports of this class of goods for three fiscal years were ; 1903, $428,427 ; 1904, $884,792 ; 1905, $1,391,877. For the year Japan's figures in the import of electrical machinery were exceeded only by British North America, $1,711,981. The United Kingdom, which in previous years has been the largest buyer of electrical machinery, has fallen off from $2,256,062 for the year ended June 30, 1903, to $1,323,019 in 1904, and $1,088,961 for the corresponding period ended this year.

By classes the electrical exports of the United States for the fiscal year 1904-5 were as follows : Electrical appliances, including telegraph and telephone instruments, $4,962,972 ; electrical machinery, $7,290,032 ; total, $12,253,904.

THE AMERICAN STREET RAILWAY ASSOCIATION.

The twenty-fourth annual meeting of the American Street Railway Association will be held in the South Building, Philadelphia Museum, Thirty-fourth Street, Philadelphia, Pa., September 25th to 30th, 1905. The Mechanical and Electrical Association and the Claim Agents Association will meet Monday and Tuesday, 25th and 26th; American Street Railway Association, Wednesday and Thursday, 27th and 28th; Accountants Association, Thursday, Friday and Saturday, 28th 29th and 30th.

The report of the Re-organization Committee will be presented and acted upon, a new Constitution and By-laws have been prepared and it is the desire of the Executive Committee that as many of the members as possible be present to consider them. Papers will be presented on Gas and other Engines, Organization, and Single Phase System for Street Railways. The Manufacturers Association is expected to have the largest and best exhibition of appliances ever shown at any convention.

Mr. W. Caryl Ely, of Buffalo, is President of the association, and Mr. T. C. Penington, of Chicago, Secretary.

The business of the United Electric Company, of Toronto, has grown so rapidly that enlarged quarters have become necessary. These have been found in the factory on King street west formerly occupied by the Cowan Company. This building has been remodelled to suit the United Electric Company's requirements, and the Company have recently taken possession of the premises.

IMPORTANT IMPROVEMENTS TO POWER PLANT.

Mr. L. A. Campbell, manager of the West Kootenay Power & Light Company, returned to Rossland, B.C., recently from a two months' business trip to the East, when he stated that the expenditure on proposed improvements would be nearly a million dollars. The intention is to build a pole line via the Dewdney trail from Rossland to Cascade and thence to Grand Forks and Greenwood, so as to furnish power to the Granby Mining Company and the British Columbia Copper Company. The distance over which the power is to be transmitted is upwards of 80 miles.

The Canadian General Electric Company, Toronto, have been given the contract for two 4,500 k.w. vertical type alternators and two 150 k.w. exciters. This order is the first two of six generators of this size to be installed in the new power house, which will ultimately have a capacity of upwards of 30,000 horse power. It is understood that the generators in the present plant at Bonnington Falls will ultimately be closed down.

The West Kootenay Power & Light Company is composed of Montreal and English capitalists, Mr. William Doull being president, and Sir Charles Ross and Mr. Charles R. Hosmer, directors.

CAUSES OF FLYWHEEL ACCIDENTS.

Wheels that serve only as flywheels have narrow, thick rims, often of approximately square cross-section. Those that serve as combined flywheel and belt wheel have thin rims, wide enough to carry the belt used to transmit the power developed by the engine.

Such wheels may fail primarily from two causes, namely, from overload or from overspeed.

Overload may be produced in a number of ways, among which may be enumerated:

(a) Clogging of the machinery in the mill.

(b) An unusual number of machines may be forced at the same time.

(c) Careless or ignorant handling of friction clutches.

(d) If the engine drives electrical machinery, the overload may be produced by a short circuit.

(e) Sudden stoppage of the engine, as when the piston comes off and blocks the piston rod.

In many instances the overload is produced suddenly and causes the wheel to fail either by the torsional strain produced, or by the crushing strain due to the pressure of the belt acting against the rim.

Overspeed causes the wheels to explode by centrifugal force. By overspeed we do not especially refer to high normal speed, although many wheels are run normally at dangerous speed. We particularly refer to the accidental increase in speed beyond that for which the governor of the engine is set, and which is commonly called "racing." Racing may be produced by:

(f) Governor being improperly designed.

(g) Slipping or breaking of governor belt or of governor pulley.

(h) Derangement of governor by internal or external causes, as when a stem or rod gets stuck, or a ball gets broken off.

(i) Derangement of valve gear.

(j) Safety stops improperly set, or governor blocked.

(k) Sudden reduction of load, as when the main driving belt breaks or an armature burns out.

Besides the primary causes enumerated above, we may mention as contributory causes:

(l) Defects in the design, material or construction of the wheel.

(m) Failure of some part of the engine, as when its bed breaks or its shaft fails and throws the wheel against the side of the wheel-pit.

(n) An idler pulley or a driving pulley may break first and derange the governor or valve gear by hurling fragments into them.

In the case of a condensing engine, racing often continues until the wheel is disrupted, even after the engineer has succeeded in shutting off the steam.

Unfortunately, when an engine starts to race the men in charge of machines in the mill shut them down, and the decrease in load causes a further increase in speed until the engine, entirely freed of its load, runs away and disrupts its wheel by centrifugal force.

LOSSES IN ELECTRIC TRANSMISSION.

The calculation of losses in power transmission is always an important part of distribution work, and the results of actual tests on transmission lines are interesting. An example drawn from practice on a New England street railway operating through several adjoining towns may be cited as pertinent. The apparatus tested consisted of a 300-kw. alternator directly connected to a 450 h. p. engine. The alternator supplied three-phase current at 380 volts to three 90-kw. transformers, which raised the potential to 13,000 volts for a 13-mile three-phase transmission over three No. 2 aluminum wires to the sub-station, where the voltage was stepped down to 380 by three 90-kw. transformers and converted in a rotary to 600 volts direct current. The frequency of the system was 25 cycles. With 530 I.H.P. (395 kw.) at the engine the direct current out-put at the sub-station was 268 kw., corresponding to about 32.1 per cent. loss, or 67.9 per cent. efficiency. The losses between the engine cylinders and the high-potential bus bars in the generating station came to 12.9 per cent.; the line loss was 5.5 per cent., and the sub-station losses 13.7 per cent. The striking point in the figures is the loss incurred in the transformers and rotary converter in comparison with the transmission line. It would seem to have been better practice to have omitted the step-up transformers in the power station and to have purchased an alternator wound directly for the line potential. The belief is increasingly held that the elimination of step-up transformers is desirable for moderate transmissions. The danger of a shut-down on account of lightning is generally considered not serious enough to preclude placing the generator directly across the line, and the gain in operating efficiency is well worth while in a steam plant.

In our August issue it was stated that Mr. L. M. Hayden, who was local superintendent at Rossland for the West Kootenay Power & Light Company, met his death by the current being accidentally turned on too soon. We understand that the current was not accidentally turned on, but was turned on by instructions received from the deceased. He instructed the man who was assisting him on this particular line to go to the White Bear Mine, which is about a quarter of a mile distant from where he was working, and telephone to the Company's sub-station, Rossland, to have the circuit that he was working on made 'alive, as he would be finished by the time his helper would reach the telephone. From the above it is evident that the deceased miscalculated the time it would take him to finish his work.

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EDITOR'S ANNOUNCEMENTS.

Correspondence is invited upon all topics coming legitimately within the scope of this journal.

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Hoffman Rotary Engine.

Some time ago the daily press contained long articles on the subject of a rotary steam engine, the invention of Mr. Wm. M. Hoffman of Buffalo, and considerable attention has since been given the matter by the technical press. When it comes to the parallel operation of direct driven alternators, the hydraulic turbine, with its constant torque, has been the ideal prime mover, and the advent of the steam turbine has certainly been a forward step. Probably the combined horizontal and vertical cross compound engine is the highest type of machine possible in the reciprocating class of apparatus, and hence the advent of a constant torque steam engine differing in principle from either the impulse or reaction turbine deserves very careful consideration. Mr. Hoffman, it is stated, has been working on his machine for over thirty years, and if the engine fulfills its claims it will occupy a very important position in the scientific world. In one feature the Hoffman engine has made a very radical departure from all past practice in rotary machines, that is to say, the piston is stationary and the cylinder revolves. It is stated that up to a very few years ago, Mr. Hoffman's efforts were concentrated upon a machine of the old revolving piston type, with which he had but little success. However, he conceived the idea of reversing things, and it is stated his success dated from the inception of this idea. It must be pointed out that in almost all engines of the rotary type, the sliding partition has been incorporated, and this has been one of the most unsatisfactory features. Lubrication is exceedingly difficult and in the past it has been almost impossible to make such partitions steam tight. While the statement that there is practically no limit to speed in the Hoffman engine may be true, still it remains that the inertia of such sliding partitions is material, and some radical method must be adopted to keep these partitions tight. That the engine will actually run is beyond question, for in one of the exhibits at this year's Exposition at Toronto, a Hoffman engine of fifty horse power was seen in operation, belted to a generator. The machine in question ran with a good deal of noise and considerable vibration, but it would be unfair of course to expect a perfect machine in one of the early types. Compared with a simple reciprocating engine of the same power, the Hoffman machine occupies but one-quarter the floor space and not more than one-half the head room.

The Fire-Fly.

For many years past the source of the light which is emitted by the fire-fly and the glow-worm has been looked upon as one of the mysteries which has been too much for even our greatest scientists, and statements to this effect have frequently occurred in the daily and technical press of the world. This statement is not really true, for we know as much about this phenomenon as we can ever hope to know about other natural manifestations. According to Dr. T. L. Phipson, the light is given out not directly by the insect, but by a curious secretion which has been isolated and studied. It is well known that certain fishes are capable of giving electrical shocks of a very severe nature, and the source of these electrical discharges has been found to be a distinct organ which is closely associated with the nervous system of these fishes.

That the phosphorescent secretion of the fire-fly and glow-worm comes from a special organ is now acknowledged, but this organ has not lent itself to the same separation as the electrical organs previously mentioned. The secretion is called "noctilucine" and is somewhat similar in characteristics and appearance to the slime given off by the ordinary garden snail. Not only is this secretion to be found in the fire-fly and glow-worm, but also in many other small animals, the phosphorescence noticeable at sea in certain localities being due to a little animal having the same peculiarities. The phosphorescence of practically of these little animals and fishes has been subjected to spectral analysis, and in every case has been found to be practically the same. The light is also of such a nature that it will affect a photographic plate, and many interesting experiments have been made along this line. The theory that these animals are able to control their luminosity is to a certain extent true, for as previously mentioned the organ which secretes the noctilucine appears to be closely associated with the nervous system. For instance, under normal conditions, the ordinary fire-fly alternates its light and dark periods perhaps ten to fifteen times per minute, but when a fly is captured it will be noticed that the frequency of such periods may at times be as high as sixty per minute. Another instance of this can be found in the "Noctiluca Miliaris," which is the animal producing phosphorescence in the waters of the sea. These animals, if in smooth water and undisturbed, remain dark, but when agitation occurs they become highly luminous. From the above it will be seen that the source of the light is not altogether a mystery but that comparatively speaking as much is known about the subject as about some other natural phenomena. That the source of the light is the same in almost all cases is now admitted and this discovery has been due entirely to the use of the spectroscope.

Electric Signs as Revenue Producers.

In our larger towns and cities the use of the electric sign has become general, and central station managers now depend on this device for a considerable portion of their income. Why such signs have not come into vogue in smaller centres is hard to say, but possibly it may be attributed to the regrettable comatose condition which characterizes such places. Through the medium of illuminated signs, the local electrical company can produce two very desirable results: First, it can obtain directly an additional revenue, and second, it can instill some life into the town, which will indirectly result in increased business. The field of the sign is almost unlimited, and with the introduction of the changeable type, the merchant is not restricted to one fixed set of letters, the novelty of which will soon wear off. By "changeable" we do not refer to the "talking" sign, but rather to that style in which the letters may be changed and redistributed by hand. The first electrical signs were, of course, on a small scale, but as time passed they were constructed along larger lines, and required an immense number of lamps for their illumination. This was a very serious drawback, for the energy consumed by a sign of even modest size might, in a year, run into three or even four figures. Then again, such signs were not really legible, and this is an all-important consideration. At certain fixed, or approximately fixed, distances, they could be easily read, but closer than this or farther away, the sign was nothing more or less than a bewildering glare, and hence its field was very limited. Besides this, as mentioned before, it required a small fortune to buy current. Modern engineering, however, has entirely overcome these two difficulties, and the electric sign of today is neater in appearance, is legible over a greater range, and has the very desirable feature of consuming much less current. This has all been done by building letters of the block type, hollowing the face of the letter, and setting the lamps in the grooves so formed. The old idea was to construct a standard sign and place sixteen candlepower lamps on it in the outline of the letters and as close together as possible. Sometimes eight candlepower lamps were used, but this construction was rare. Nowadays, the four candlepower has been adopted for signs of even large size, and with the special type of letter has been found entirely satisfactory. As an example of the two types of construction, we would cite a case which recently came before us in Toronto. A certain merchant wished to put up an electric sign, containing five letters, and the height and the breadth of the letters were specified. One tender covered a sign containing two hundred sixteen candlepower lamps, while another required but one hundred and ten four candlepower lamps. The latter was accepted, and the sign today is one of the clearest in the city, and is as well illuminated as could be desired. The central station man who is selfish would have favored the other sign, but such a short-sighted policy would have produced poor results. The man with a good sign, which takes very little energy, is going to be the best and most satisfied customer. If the local managers in whose towns there are no signs will begin a campaign of education with their principal business men and induce them to install something along this line, the other merchants will not be long in following, and this will result in a revenue which will be very well worth while. It is rapidly becoming the policy for central stations to supply merchants with electric signs free of charge, it having been found that the initial cost of such signs is considerably below the annual revenue produced. This proposition may be considered on a par with the question of free lamp renewals. An immediate expenditure of money is required, but in the long run the policy is a paying one, for it results in satisfied customers. Of course with the old type of sign it was doubtful if this scheme could be carried on to advantage, as such signs were not changeable in any sense of the word, and this meant that the money invested in any particular sign was practically lost should the customer decide to discontinue its use. However, with the changeable type previously mentioned this loss does not occur, for should the consumer decide to do without this form of advertisement, the old sign may be taken back and remodeled to suit the requirements of some more enterprising merchant. We would most earnestly suggest to those who are in charge of the management and operation of our central stations, that immediate consideration be given to this proposition, as it has been the experience elswhere that the electric sign is a very satisfactory scheme. In any event, no loss can result if the idea be properly handled, while on the other hand a very material revenue may be derived.

GAS VS. STEAM ENGINES.*

Modern industry has witnessed the development of a great rivalry among different types of motors, which is as interesting as it is important. The time has passed when the constructor's sole aim was to produce an apparatus capable of supplying high power. The question of output at present dominates all others, and all efforts are now directed to produce engines which will utilize the energy at disposal to the best possible advantage. Owing to the variability of the power which they absorb, wind motors, the use of which might have been economical in many cases, have only been applied in a very few instances, and it is hardly possible that their use will become general. The drawbacks of these engines are too well known to render it necessary for us to deal with them. The cost is also well known which is necessitated by hydraulic installations. Water turbines can hardly be used unless it be under special conditions, and this is only the case where the configuration of the ground renders means of transportation of fuel difficult, so that it then becomes best to have recourse to hydraulic power whensoever such is available. Unfortunately Nature has been somewhat parsimonious in endowing many localities with this source of energy. Another reason which enables hydraulic apparatus to be dispensed with is that the development of the plant in view is not always in proportion to the size of the works that would have to be erected for the purpose of catching up and storing the necessary water.

It is chiefly between the gas and steam engine that the struggle appears to be going on, and without siding with those engineers who predict the defeat of steam, we think that, despite its construction, its upkeep and more delicate regulation in general, the gas engine is a most serious rival to the steam engine. In the present state of affairs its victory depends solely upon the nature of the fuel which can be used in each different region. The thermic output of the gas engine is much superior to that of the steam engine ; while the best engines of this type do not exceed 10 per cent., gas engines generally attain an output of 20 per cent.

The most vital importance of the question lies especially in its decision when it is a question of selecting motors for use in large central electric stations.

Due to the simplicity of its installation and the relative reduction of the costs of installation and working, the gas engine must only give way before the electric motor, but it is undoubtedly superior to the steam engine, especially when it is fed with poor gas. Let us take for example the case of a fifty-horsepower installation. If effected with a good steam engine of the Ridder type first costs will be incurred amounting to about $4,000. This expense will be reduced to $3,400 at most if a good gas engine be selected with a gas producer, while in addition to this there must be added a saving of fuel amounting to just one half.

But beyond a certain power, say 500 horsepower, this superiority becomes less evident. Large engines are, as a matter of fact, intrusted to expert engineers and stokers, who attend them and set them to work under the most favorable conditions. Furthermore, in comparison with the gas engine, the steam engine has the advantage that it is backed up by the experience that has been acquired during nearly a century of practical work.

The use of condensing, multiple expansion and then superheating have enabled a saving of fuel to be effected which no one dared to dream of about twenty years ago.

On the other hand, the cost of the foundation and other work required for the installation are factors which must also be borne in mind.

Some firms, however, have constructed portable and semi-stationary engines, the output of which may be compared with that of the best ordinary engines. But, whatsoever their merits, they are only suitable for large central stations, and they can hardly be used for obtaining powers exceeding 200 or 300 horsepower.

The steam engine has taken another form, viz., that of the turbine, of which there are now many types in existence. The turbine is an excellent motor for pressures of not much importance. A French engineer, M. Rateau by name, has pointed out an application for turbines which is, through recuperators, destined to render important service in connection with the use of waste steam.

This, however, is a special case of which there can be no question when it is necessary to create a large central station, and for current steam pressures (which can alone come into consideration for these establishments) the qualities of the turbine, from the point of view of yield, are less demonstrated. Let it even be assumed that they are established ; let it be assumed that the steam turbine is the equal, as regards yield, to the best types of compound steam engines with condensation and superheating. Would it be necessary then to conclude from that that it is superior to the gas motor ? Because, like this latter, it only requires little foundation, produces but slight oscillation and is essentially adapted to driving electric generators. This would be forming too hasty an opinion.

In Europe the gas engine is believed to be superior to the steam engine, on account of the simplicity of its installation and its lesser consumption of fuel ; for these reasons its future is essentially bound up with that of the gas producer. It would seem that if there exists in the country fuel suitable for cheaply charging gas producers, then the construction of these latter and the installation of "poor gas" engines may be recommended for any purpose and for any type of establishment. They need but little space, they cost less for fuel, while the quantity of water they need is small. As a matter of fact, even in Europe, where more attention has been paid to the poor gas question than in America, the number of electric central stations using gas engines is not very large, and if some constructors have been able to realize units of considerable power of as much as 1000 to 2000 horsepower, very many others have failed in their attempts, to the great detriment of poor gas. But most of the trials were premature on the part of those who undertook them, and the trials made were often more rash than well thought out. In view of the more and more imperative necessity of producing cheap motive power, recourse was had to the use of special low price gases, which gave recognition to the advantages of high compression and the increase in the piston speed. High pressure, while assuring a better dealing with the products of combustion, also permits of the use of apparatus wherein the explosive power does not exceed the average mean. Thus it becomes possible, with 14.1 cubic feet of mixture containing twelve parts of air and under a pressure of 26.5 lbs., to realize the same amount of work with 17.6 cubic feet of the same gas and eight parts of air compressed under 11 lbs.

It will, of course, be understood that it is essential to combat the increase in temperature that takes place in the breech of the piston and in the valves by means of an arrangement of these latter in a special manner, and also, if need be, by separately cooling the jacket of the piston breech and that of the cylinder itself.

Special care should also be paid to ignition. The magnetic spark gives sufficient guarantees, but still better can be done. It suffices to provide the chamber with two independent ignition devices. In this way a perfect guarantee is obtained as regards premature ignition. But, while bearing all these advantages in mind, some persons have not been able to turn them to account, because they thought that they could realize the utilization of high pressures without modifying the construction of their cylinders and without changing the compositions of their mixtures. Among these persons we must include most French, English and American constructors. German constructors have, generally speaking, been more wide-awake and have adopted, for poor gas motors of the usual type, compressions of 17.5 lbs., 26.5 lbs. and even more.

Hence the thermic yield generally exceeds 20 per cent. in their apparatus, even in those of very powerful type ; hence it is double that obtained with the best steam engines.

The principal types of gas motors used in Europe are the Taylor, Crossley, Fetu, Defize and Campbell type, generally of low power ; there are also the Stockport and

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* Extract from a paper on European Gas Producers, by Emile Guarini.

Cockerill, attaining as much as 500 horsepower, and the Koerting single-action, four-cycle motors of small and medium size ; the larger types are of double action and on the two-cycle principle. Of this latter type there are specimens in existence of the high-pressure variety attaining 500 to 1000 horsepower. Some have even been supplied for powers of 1800 and 2000 horsepower. They are less cumbersome than those of other constructors who have recourse to two and four-cylinder combinations. The Crossley engines have also been improved and 200 and even 1400 horsepower types are now built.

We must not forget to speak of the Letourbe engines. Since 1902 A. Witz, during some trials with a triplex, 300-horsepower, super-compression Letourbe engine fed by a gas producer built by the same maker, obtained the horsepower hour with 81 lbs of coal (anthracite, from Auzin) containing 14.8 per cent. of volatile materials and 3 per cent. of cinders.

The "Splendid" engine also merits some mention. This engine works at mean compression, but the surfaces in contact with the steam are reduced as much as possible.

Although the quantity of fuel consumed depends as much upon the nature of the motor as upon the gas producers themselves, we have still thought it well to mention the results obtained.

1. The electric station of the Tunis gas works. The station which supplies the current for lighting the European and native town comprises three Pierson gas producers of 150 horsepower each, feeding four electro-generating groups driven by a 160-horsepower Crossley motor. The fuel used is coke, all of which is obtained from the works themselves, as described in these columns heretofore.

2. Water pumping station of the town of Bale. An installation of pumps with motors and Otto-Deutz gas producers showed a consumption, all losses included, of 1.65 lbs. of coke per horsepower hour.

3. The Dion-Bouton Works (Poteaux, Seine, France). A Pierson gas producer of 300 horsepower feeds six forty-horsepower motors, each driving a dynamo for the supply of power and lighting. Anthracite coal is the fuel used. The consumption amounts to .92 lbs. per horsepower hour, including ashes, clinkers, etc.

4. Thonwaaren-Fabrik (Embrach, Switzerland). Three Dowson-Winterauther gas producers. This plant is not without presenting some remarkable features, and it feeds four motors which operate three-phase generators. After a continuous trial of one year's duration it has been found that the consumption per effective horsepower hour of coke or anthracite does not exceed an average of 1.01 lb.

5. The works of the Fives-Lille establishment. Two Letombe gas producers, using anthracite coal, supply poor gas to a 300-horsepower Letombe motor. The consumption realized during ten hours trial, made by M. Witz, did not exceed .81 lbs.

6. The Barcelona Tramways Works. The plant comprises three Fichert-Heurtay gas producers, each of 200 horsepower, feeding three Crossley engines, two of 165 and one of 300 horsepower. These motors drive Thury dynamos. The consumption per hour without deducting ashes and including the fuel consumed during stoppages, etc., amounts to 1.61 lbs.

7. The works of the Cassel (Germany) Electric Tramway Company. One Pierson recuperator gas producer, the consumption of which is 1.45 lbs. of Anzin close-burning coal per horsepower hour, ashes and clinkers included, is used for feeding three Crossley engines which drive some electric generators.

8. The works of the Societe Glaciere of Paris, at Briche, St. Denis, Seine. A Pierson gas producer feeds one 165-horsepower Crossley engine. It is fed with Anzin close-burning coal. The output amounts to nineteen pounds of ice per pound of coal, whereas, with steam engines of the most improved type, it only amounted to from seven to eight pounds with the same quantity of fuel

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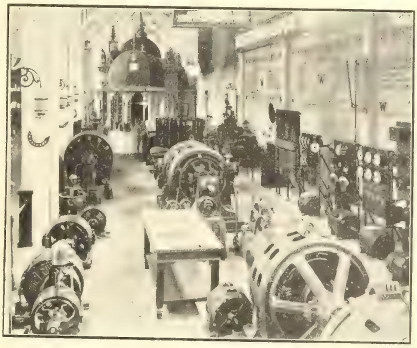
Mr. W. A. Richard, of Aurora, Ont., has purchased a 50 k. w. S. K. C. alternator, switchboard and exciter from the town of Berlin, Ont.

THE WESTINGHOUSE EXHIBIT.

At the Lewis and Clarke Exposition, Portland, Oregon, in the building devoted to machinery, electricity and transportation, the Westinghouse Electric and Manufacturing Company occupies 1,500 square feet of floor space. This section is devoted to the display of many kinds of generators, motors, controllers and instruments of every description.

Starting in at the main entrance to the exhibit the attention of the visitor is attracted by a 400 kilo-watt Westinghouse-Parsons turbo-generator unit. To the left is a show case containing all the standard types of portable instruments, and just behind this is an electrically operated distant control automatic oil circuit breaker, designed to open a 200 ampere 33,000 volt circuit.

Passing on down the aisle are seen a No. 92, fifty horsepower direct current and a No. 107 seventy-five horsepower alternating current series railway motor, and a switch group of the multiple control system. To the right is a group of type S motors, including a vertical type machine, a 25 kw. rotary converter and a 2 kw. type S generator direct connected to an Ohmen high speed engine manufactured by the Ohmen Engine Works of San Francisco, Cal. Across the aisle is a motor generator set consisting of a 150 horsepower induction motor and a 100 kw. direct current engine type generator, and in immediate succession are a group of type R direct current motors, 1-6 to 1 horsepower, a 120 kw. revolving field self-contained A.C. generator and a 100 horsepower Type HF induction motor.


Portion of Westinghouse Exhibit at Lewis & Clark Exposition, Portland, Oregon.

In the rear section are some distinctive types of Westinghouse transformers, including a 110 kw. air blast transformer, a number of Type OD, Type N, manhole type. Five OD transformers, ranging from 7 1-2 to 25 kw., are mounted on the wall. On turning to the left and walking towards the main entrance may be seen a group of induction motors, Types H and CCL for constant speed work, and Types F and C for variable speed service. A line of special motors both A.C. and D.C. for crane service is also shown. Standard switchboard instruments, comprising voltmeters, wattmeters, ammeters, power factor meters, etc., are arranged on display boards against the wall. In the controller section are found an oil-immersed auto-starter for use with the CCL motors, a rheostatic controller for the Type HF motor, an elevator controller used with Type F motors, an automatic pump controller and finally a three-wire double voltage controller for use with direct current motor in machine tool drive. Near the center of the exhibit is a rope hoist manufactured by the Denver Electric Company, to which is connected a No. 103 A Type F induction motor. Various classes of fuses artistically arranged on a board, a double throw oil switch, a static interrupter, choke coil and lightning arresters complete the display.

The exhibit is illuminated by two large "Westinghouse" display signs, and by series multiple arc lamps suspended from artistic goose-neck posts. It might be mentioned in this connection that the entire building is lighted by lamps of similar pattern.

SPECIFICATIONS FOR ELECTRIC LOCOMOTIVES.

The Temiskaming and Northern Ontario Railway Commission have invited tenders for the furnishing of four electric locomotives for the operation of the first section of the Temiskaming and Northern Ontario Railway from North Bay to New Liskeard, a distance of about 135 miles. The decision to adopt electric power on this road is regarded as a most important step and one which is likely to have a wonderful influence upon the progress of electric traction. The specifications are naturally interesting to the electrical fraternity, and are printed below:

SPECIFICATIONS.

Clause 1. Purpose. These specifications are intended to cover the supply of all material and the performance of all labor incident to the manufacture, the delivery at North Bay, Ontario, and the commercial test upon the line of the Temiskaming and Northern Ontario Railway of four or more electrically operated locomotives for the Temiskaming and Northern Ontario Railway Commission. The specifications shall be considered general and are submitted to possible tenderers as a guide to their engineers for the design of locomotives which they will recommend as best suited to the requirements set forth or intended to be set forth herein.

Clause 2. Terms. Wherever the word "Commission" is used in these specifications it shall be taken to mean the Temiskaming and Northern Ontario Railway Commission.

Wherever the word "Contractor" is used in these specifications it shall be taken to mean the party or parties to whom shall be let the contract for the supply of the electric locomotives as herein specified.

Wherever the word "Engineer" is used in these specifications it shall be taken to mean the Engineer of the Temiskaming and Northern Ontario Railway Commission, duly appointed by them to serve in such capacity for the electrical equipment of the railway under their charge.

Clause 3. Contractor's Drawings. Immediately after the contract for these locomotives shall have been awarded, and before materials or equipment shall have been ordered, or the work of construction commenced, the Contractor shall prepare a complete set of general drawings of the locomotives and shall submit one copy of each drawing to the Engineer for his approval; but such approval shall not in any way relieve the contractor of full responsibility for the correctness of the design or for the proper and efficient working of the electric locomotive supplied.

After drawings shall have been once approved by the Engineer, no change in design covered by such drawings shall be made without his written consent.

After all drawings, general and detail, shall have been completely revised and corrected, the contractor shall supply to the Commission free of cost three full sets of corrected blue-prints of such drawings.

Clause 4. Number required. There are required for the operation of the railway at least four locomotives: two of these to be of the freight class, and two of the passenger class.

The locomotives shall be identical, with the exception that a gear ratio shall be used on the freight locomotives which shall differ from that used on the passenger locomotives; each gear ratio to be chosen as best suited to the service requirements of the locomotive to which it is applied.

Clause 5. General Conditions. The track on which these locomotives shall operate is single; is laid upon gravel ballast, and consists of steel rails weighing eighty (80) pounds per yard, A.S.C.E. section, laid upon tamarac ties 7" x 7" x 8'. There is but one overhead bridge structure in the one hundred and thirty-five miles of railway; and with the exception of a few short trestles, a solid roadbed is continuous.

The uniform clearance from top of rail to trolley wire is approximately twenty-one feet all as indicated on drawing marked exhibit "C"; the profile and route of the Railway are shown on the drawings marked Exhibit "A" and Exhibit "B". The gauge of the track is standard.

Clause 6. Type. It is intended that these locomotives shall operate from a supply of single phase alternating current of a frequency of twenty-five cycles per second. This current will be supplied at a potential difference of nominally sixty-six hundred volts between overhead conductor and rail.

Note.—If bidder so desire he may quote on locomotives which shall receive their power from a three phase alternating current circuit, such alternating current to have a frequency of twenty-five cycles per second. In such case the bidder shall submit, in addition to his locomotive specifications, a full description, with suggestive outline plans, of the line construction, substation equipment, and power house electric equipment necessary for the operation of trains evenly distributed over the 135 miles of single track, and drawing a five minute total maximum of five thousand electrical horse-power in units up to one thousand horse-power; he may consider the average total load to be twenty-five hundred horsepower.

The body of the locomotive shall be of rectangular cross-section; an entrance shall be provided at each side and each end of the cab.

The entire locomotive structure shall be fire-proof.

The locomotive shall have at the option of the bidder three or four driving axles, to each of which shall be geared an electric motor.

Clause 7. Capacity. A locomotive of the passenger class shall be capable of making the trip from North Bay to New Liskeard in two hours and fifty minutes with a train of two hundred and fifty tons, exclusive of the locomotive. In performing such service the temperature rise in any part of the motors shall not exceed at any time 85°C. above an air temperature of 25°C. The locomotive shall be capable of continuous efficient running at speeds lower than those involved in the above requirement.

Note.—There are sixteen permanent sidings located along the line at distances from North Bay as indicated on accompanying Exhibit "B" at which stops of one minute each shall be made.

A locomotive of the freight class shall be capable of hauling a train of twelve hundred tons, exclusive of the locomotive, from New Liskeard to North Bay, making stops at each siding. In climbing the grades, which do not exceed one per cent. and are of a maximum length of 8,600 feet, the speed of the train shall not fall below ten miles per hour.

Bidder shall state the speed which the freight locomotive will be capable of developing upon a straight and level section of track, such as defined on pages 11 and 12 of the 1902 report of the Committee of Standardization of the American Institute of Electrical Engineers.

Bidder shall state the time required by the proposed locomotive in bringing this twelve hundred ton train, upon a straight and level track, to its free running speed. He shall also state the maximum tractive effort which this locomotive can exert under conditions of a lowering of twenty per cent. in the supplied trolley voltage. Under these conditions there shall not be developed at any time in the motors a temperature rise of more that 85°C. above an air temperature of 25°C. The locomotives shall be capable of performing daily the services above described without developing a rate of depreciation greater than that common in direct current railway practice.

In calculating the tractive effort it shall not be considered possible for the locomotive to exert on dry clean rails, without sand, a draw-bar pull in excess of twenty-five per cent. of the weight upon its driving axles.

Clause 8. Control. Each locomotive shall be equipped with control apparatus for the electric motors and the air brake system in such a manner as to be capable of being handled from either of two cabs located one at each end of the locomotive. The locomotives shall be so equipped as to be capable of control, when coupled together, from either cab of either locomotive; the air compressors and main reservoirs shall be arranged to be workable in multiple so that each shall take its share of the breaking duty.

Manipulation of the control shall be done by means of compressed air, though other and manual means shall be supplied which can safely be used in the event of temporary failure of the pneumatic equipment. The current collector shall be of the bow type having sliding contact, with a centrally located overhead trolley wire. To insure distribution of the wear of the collector the working conductor will be staggered in a horizontal plane.

Clause 9. Wiring. All high tension wiring shall be carefully insulated and carried, with as short leads as may be possible, in suitable grounded metallic tubing. All wiring and contacts shall be, so far as reasonable, protected from possible contact with the persons of those legitimately engaged in the prosecution of their duties upon the locomotive. All reasonable and proper precaution shall be taken to make the mounting upon and the operation of the locomotive safe.

Clause 10. Protection. All the electric equipment shall be protected in the best manner known from possible injury due to lightning discharge or switching effects.

Clause 11. Heating Apparatus. There shall be installed upon each locomotive a heater of capacity sufficient to supply steam for the proper heating of six passenger cars of ordinary day coach of Pullman type, complete with piping and hose connections, as recommended by the Master Car Builders' Association.

Clause 12. Trucks, Fenders, etc. Each locomotive shall be provided with single axle leading and single axle trailing trucks; these trucks to take only such share of the weight of the locomotive as will enable them surely to perform their proper guiding and steadying functions. There shall, be provided moreover at each end of the locomotive a strong and suitable fender or cow-catcher.

Couplers are to be of the vertical plane automatic type, all as specified on pages 44 to 51 of the Master Car Builders' Association's Standards and Recommended Practice, 1904.

An efficient track sanding system of capacity not less than five cubic feet, pneumatically operated with multiple unit control, is to be provided.

Clause 13. Brakes. Each locomotive is to be equipped with a system of automatic air brakes complete with compressor, main reservoir, double scale gauge, and duplicate control outfit, suitable for the safe and ready management of a train of fifty empty cars.

Each locomotive shall be equipped with piping, valves, and whistle for the operation of an air signal system; this shall be properly connected to the compressed air system above outlined.

A suitable double end whistle set with cut out cocks, valves and auxiliary air reservoir shall be installed in each locomotive.

Clause 14. Measuring Instruments. Proper and efficient instruments shall be provided for the continuous measurement of current, voltage and power supplied to the main motors; also a recording wattmeter.

Clause 15. Guarantee. Contractor shall guarantee the mechanical strength and durability of all parts of the locomotive, and shall hold himself liable to replace, when called upon to do so, any and all portions of the equipment, which with ordinary care shall have proven themselves unsuitable or defective within a period of one year after the formal acceptance of the locomotives by the Commission.

Clause 16. Tests. Each locomotive shall be operated under ordinary service conditions on the tracks of the Temiskaming and Northern Ontario Railway by the Contractor without expense to the Commission for a period of two weeks after the line and road-bed shall have been prepared for such tests; and during this period it shall be submitted to such tests as will be required by the Engineer of the Commission to satisfy himself that the requirements of the specifications and contract shall have been met.

In addition to these tests, accurate measurements by dynamometer car on the tracks of the Temiskaming and Northern Ontario Railway shall be made of the draw-bar pull possible at various speeds under voltage conditions similar to those under which the locomotive is to be operated in actual daily service; and of power and current consumption under operating conditions.

In case of failure of the locomotive or any part of its equipment to meet the specifications there shall be allowed the Contractor reasonable time to remedy the same. Should the Contractor be unable to do so it shall be the privilege of the engineer to reject the locomotive as unsuitable for the requirements of the Commission.

In the event of the passenger locomotive failing to meet the time condition above specified the Commission may deduct from moneys due to or to become due to the Contractor a sum equal to one per cent. of the contract price for every five minutes taken by the locomotive with the 250 ton train beyond the specified time.

In the event of the freight locomotive failing to haul in the specified manner the 1,200 ton train the Commission may deduct from moneys due or to become due to the Contractor a sum equal of one per cent. of the contract price for every 10 tons or fraction thereof by which the maximum train which it can so haul is less than 1,200 tons.

The locomotive shall not be offered to the Commission for acceptance until the Contractor shall have secured written approval of them, for such acceptance from the Engineer.

INSTRUCTIONS TO BIDDERS.

Bids will be received by the Temiskaming and Northern Ontario Railway Commission up to October 31st, 1905, for the manufacture, delivery and test, according to the accompanying specifications, of four or more electric locomotives; such to be operated by single phase alternating current (except as indicated in "Note" under clause (6) of the specifications).

Each bid shall be enclosed in a sealed envelope marked "Tender for Electric Locomotives," and addressed to the Secretary, Temiskaming and Northern Ontario Railway Commission, 25 Toronto Street, Toronto, Ontario.

Prices shall be submitted for locomotives delivered complete on the understanding that at least four locomotives will be purchased; moreover bidder shall submit a unit price at which he is willing to enter into contract for the immediate supply of one or more additional locomotives of essentially the same design.

Bidder shall submit with his tender detailed specifications of the locomotive he proposes to furnish, which, along with these instructions, general specifications, and drawings mentioned below shall form a part of the contract to be entered into.

Bidder shall submit with his tender drawings as follows:

I. Outline drawing of locomotive, showing general dimensions, and general design of each main part.

II. Diagram showing the arrangement of circuits, and apparatus proposed for the electric operation of the propelling motors and of the auxiliary equipment.

III. Outline drawing of the air equipment, giving name of maker and general description and capacities of parts.

IV. Diagram showing the approximate gross weight of the locomotive, and the distribution of this weight upon the various axles.

V. Curves and diagrams as follows, showing the characteristics of the motors: speed-time; ampere-time; volt-time; ampere-speed, tractive effort, power factor, efficiency, field losses, armature losses, core-losses, brush losses; time required with various loads to bring (a) fields and (b) armature from an air temperature of 25°C. to a temperature of 100°C.; temperature rise with various currents in (a) fields of motor, and (b) armature. If the performance of other locomotive apparatus shall effect the net transformation of the supplied electric power into mechanical power such as transformer, motor-generator sets, or other intermediate equipment, then the performance of these shall be indicated by suitable curves or tables.

Bidder's specifications shall describe completely all parts of the equipment, and shall include a list of these parts, and of the tools, fixtures, etc., to be provided.

It shall further contain these dimensions:—

General: Diameter of driving wheels.
Total wheel base.
Rigid wheel base.
Length over all.
Total height of locomotive above rail.
Overall width of locomotive.
Diameter of driving axle and size of bearings.
Number, size, location and movement of windows.
Number, size, location and movement of doors.
Motors: Clearance, armature periphery to pole-face.
Diameter of commutator.
Length and thickness of brush.
Gear ratio of each class of locomotive.

The contract form will contain clauses protecting the Commission from monetary loss due to patents, negligence, defective material or workmanship, or to use of unproven apparatus. In case of experimental apparatus being permitted to be used, Contractor will be allowed reasonable time to remedy defects appearing; of the effectiveness of such remedy the Engineer shall be the final judge.

Bidder shall specify the earliest time of delivery, ready for test, which he will guarantee for each and every locomotive, such time to date from the period of formal signing of contract by the parties thereto. In the event of this contract time being exceeded a penalty of twenty-five dollars ($25.00) per day per locomotive for each day of such excess shall be forfeited to the Commission by the Contractor, which money may be deducted from money due or to become due to the Contractor.

The Commission reserves the right to reject any or all bids; the lowest tenderer will not necessarily be considered the best bidder.

INVENTION *and* DEVELOPMENT

IN THE ELECTRICAL FIELD

New Incandescent Lamp. A Frenchman named Canello has devised a new incandescent lamp having a filament formed of oxides of alkaline earths covered with a thin layer of metallic osmium.

Metalized Filament.—In a paper read before the Ohio Electric Light Company, Mr. F. W. Wilcox describes a new filament which is the result of a discovery made at the research laboratory of the General Electric Company at Schenectady, N. Y., and has been developed by the laboratory of the lamp works of the same company at Harrison, N. J., where it is now under production. In order to understand the nature of this new filament and the processes employed to obtain it, it will be well to first explain how the ordinary carbon filament is produced. As is generally known, lamp filaments are at present made by squirting a solution of cotton or other form of cellulose through a die forming a thread or fibre which is then hardened and dried. After shaping into the required form for the lamp filament, this is carbonized by heating in a muffle. This produces the raw carbon or base filament, as it is called. These base filaments are then separately heated (by passing current through them) in a vessel exhausted of air and containing only hydrocarbon vapor. This coats the filament with a shell or layer of graphite carbon and the filaments are then said to be "treated" filaments and this is the completed form of the present filament.

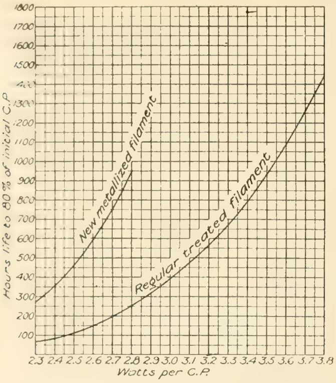


FIG. 1.—CURVES OF USEFUL LIFE AT VARIOUS EFFICIENCIES FOR NEW AND PRESENT FILAMENTS.

The new filament is obtained by applying additional processes to the present carbon filament, which include heating the filament in the electric furnace at a temperature of from 3,000 to 3,700 degrees centigrade. This "firing", as it is termed, is performed both before and after treating. This results in producing an exceedingly pure form of carbon having considerably less specific resistance and greater density than the present filament. The process also changes the temperature coefficient from negative to positive.

The present filament (as may be seen in a high candlepower lamp) starts dim and surges up to the full brightness, whereas with the new filament this is reversed, that is, it is very bright at starting and then declines to normal brightness. The practical effect of these new processes on the filament is to make it more refractory, *i. e.*, capable of withstanding a higher temperature for a given rate of deterioration. This enables the filament to give a greater amount of light per unit of surface, *i. e.*, operate at a higher efficiency.

The actual gain in efficiency is twenty per cent. over present highest standard efficiency of incandescent lamps. This is a considerable gain, the value of which can probably be better appreciated by reference to curves in Fig. 1. These curves show the useful life performance at various efficiencies for the new and old filaments and the radical improvement in life values is graphically portrayed.

The feature of special interest in these new lamps is the improved carbon filament which gives a veritable two and one-half watts per candle lamp—securing a clear gain of twenty per cent. in efficiency for the same life and candle-power performance over the present standard 3.1 watts per candle lamp—marking the greatest improvement in lamp quality since the introduction of the treated filament.

New "Wunder" Arc Lamp.—The Ball Electric Company, of Brooklyn, N.Y., have placed on the market a direct-current constant-potential enclosed arc lamp, called the "Wunder." This lamp has been constructed to burn on 100 to 130 volt direct-current circuits, and is adjusted to consume five amperes of current, which is the accepted standard. This current may be varied, however, one way or the other. Ample provision is made for the liberation of heat above the arc enclosure to prevent the transmission of any additional heat to the operating works, with its deteriorating effect on the insulated wire of the magnets. The lamp contains an efficient vent for the escape of gases. The supply of oxygen to the arc is restricted in such a manner as to insure long life to the carbon. The length of the lamp is, over all, 26 inches. The operation of feeding the mechanism of the lamp is actuated by double solenoids with a U-shaped armature, which is connected to a dash-pot and clutch by a rod, the whole being mounted on a central tube carrying the upper carbon holder. It is asserted that the lamp will burn from 150 to 170 hours with one set of carbons. The most satisfactory result in the life of the lamp is dependent upon the quality of carbons used and the amount of current consumed.

New Induction Motor.—The services of Mr. H. M. Hobart, of London, Eng., a well known authority on induction motor design, were retained by the Commercial Electric Company, of Indianapolis, with the result that a new line of induction motors has been placed on the market. It is well known that in order to produce a high power factor in induction motors it is essential that there shall be a limited clearance between the rotor and stator. In the present motor the design of the stator frame and stator head is such that an equal division of this clearance is always secured and maintained, it being an impossibility to assemble the machine in such a manner as to give the rotor an unequal air-gap on opposite sides. In order to reduce the wear of the rotor shaft to a minimum, very large bearing surfaces have been provided. The bearings are also so designed that if the operator should flood them with oil no damage to the machine could possibly occur. The bearing linings are duplicate and interchangeable, thus it is claimed, making the replacement of the bearing a much more simple and less expensive matter than is involved in the accurate readjustment of "adjustable" bearings. The shaft is accurately ground to gauge, the bearings are polished and the rotors are mounted on the shaft by means of hydraulic pressure. Ventilating apertures are provided across the faces of the stator and rotor cores, thereby causing a free circulation of air and insuring cool operation.

New Single-Phase Traction Motor.—A new type of single-phase motor has been designed by Bruce Peebles & Company, of East Pilton, Edinborough. The motor is of the compensated repulsion type. For a two-pole field there are four brushes, two carrying the main current and the other two being short-circuited. To simplify the construction, one of the four brushes has been discarded in a recent improvement, leaving but three placed approximately 120 degrees apart. Two of these brushes are short-circuited, thus acting as the brushes for the repulsion action, while the pair together acts as a single brush for carrying the main current. In still another type, control is obtained by means of an induction regulator acting upon the field of the motor. The stator consists of a high-potential winding which acts as the primary of the transformer, the secondary of which supplies low low-voltage current to the armature. The advantages of this arrangement are said to be simplicity, lightness and efficiency equal to that of any other system, while giving a higher power factor.

New Storage-battery Cell without Lead.—An interesting account of a new storage-battery cell which does not make use of lead in the electrodes was given by Dr. Grefenberg at a recent meeting of the German Bunsen Society at Carlsruhe. The positive electrode is formed of black nickel hydrate, obtained by chemical oxidation of the lower nickel hydrate formed at the anode in an electrolytic cell. The negative electrode is formed of iron powder, obtained by reducing ordinary forge scales of iron oxide by hydrogen gas at 380° C. The nickel oxide is then mixed with 40 per cent. graphite, and the pulverized iron with 10 per cent. of the same, this graphite being covered with a coating of electro-deposited nickel before use. The materials are then pressed into briquettes, and these are enclosed in small capsules of thin nickel sheet, and again submitted to pressure. Ten of these charged capsules are joined together to form the positive and negative plates of the cell. The author exhibited such a cell, containing six pairs of plates, enclosed in a box of sheet steel, this box being pressed out of one sheet, and, therefore, without joints. The total weight of this cell was three kilograms, made up as follows: Active materials of the cell, 900 grams; metal capsules and supports, 750 grams; electrolyte, 625 grams; steel box, etc., 725 grams: total, 3,000 grams. The electrolyte used is a 20 per cent. solution of potassium hydrate. Under normal conditions of four hours' discharge the cell yields 35 to 40 ampere-hours, with a mean electromotive force of 1.23 volts, representing 16 to 18 watt-hours per kilogram of total weight. The capacity of the cell diminishes only slightly with increasing current densities, so that it is especially adapted for use on a large scale. By quick discharge after charging, the current efficiency of the cell is 95 per cent. and the energy efficiency 65 per cent. Twenty-four hours after charging, the corresponding figures are 63 per cent. and 42 per cent., respectively. This difference arises from the gas production and self-discharge which occurs on standing, due to decomposition of the water in the cell. The iron electrodes are acted upon by air, so that transport of the cell is not effected without difficulty. The reduced iron electrode burns in air, while the oxidized electrode oxidizes further to the higher oxide, and this oxide is very troublesome to again reduce to the metallic state. On the other hand, the new form of secondary cell stands rough usage well, and short-circuiting does not even harm it. After 100 discharges the cell loses only 12 per cent. of its original capacity; after 200 this loss has risen to 17 per cent. The cause of this depreciation is not yet explained.

NEW INDUSTRIAL PLANT.

The Keewatin Flour Milling Company have closed a contract for the machinery of one of the largest flour mills on the continent. The equipment will be equal to 40,000 barrels a day and provision has been made for a further output of 20,000 barrels.

The successful tenderers were the Allis-Chalmers Company, of Milwaukee, who have built many large flour mills in the United States. The amount involved will be about $225,000. A considerable portion of the machinery will be constructed at the works of Allis-Chalmers-Bullock, Limited, in Montreal. The contract calls for the installation of the Universal bolter system throughout. The power is derived from the Lake of the Woods and wherever possible electricity will be used in the operation of the plant. A separate water-wheel will be installed to generate the current, and the elevator of 500,000 bushels capacity, the car pullers, the wheat shovels, the passenger and freight elevators, the cooper shops, etc., will be run by electricity.

The mill building and elevator, now under construction by the Macdonald Engineering Company, of Chicago, will be completed by the 1st of January. Mr. John Mather, of Ottawa, is president of the company and a number of Ottawa capitalists are interested.

Mr. Isham Randolph, hydraulic engineer, Chicago, has designed a scheme for the building of a wing dam for the Queen Victoria Park Commissioners to raise the level of the water in the city waterworks intake. A concrete tower, seven feet square and fifty-eight feet high, will be erected on the shore, and upset into the shallow water near shore, where it will lie on the bottom, forming a submerged dam. The tower will be built in sections, connected to heavy chains. When it falls into the river the sections will break apart, so that the dam will conform to the river bed, while the chains will hold them in line. The tower is now in course of erection.

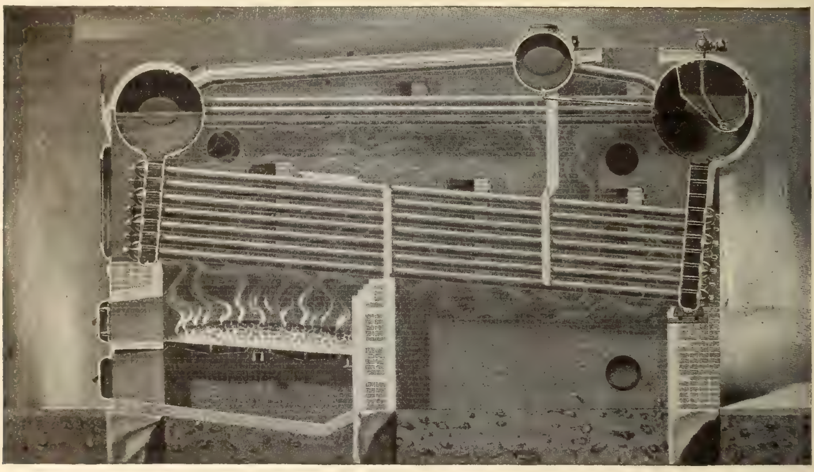
THE CANADA WATER TUBE BOILER.

The Canada Foundry Company, Limited, have acquired the patent rights to manufacture in Canada the "Atlas" water tube boiler so well known in the United States. It will be called the "Canada" boiler, and we understand that a number of orders have already been booked for early delivery.

GENERAL DESIGN.

The Canada boiler is built on simple straight lines. It consists mainly of three drums and two water-legs extending crosswise and the tubes running lengthwise; thus all tube surfaces run in one direction and all plate surfaces in another, producing universal flexibility and the avoidance of the unfortunate results oft-times experienced from unequal expansion and contraction as between the thin tubes and the thick plates of drums when both tubes and drums run lengthwise. That the longitudinal expansion and contraction is uniform and general throughout the entire width and height of this boiler has been definitely established by actual measurements taken at top and bottom before firing and again after full working pressure has been reached. The expansion and contraction of the tubes is well taken care of by mounting the rear water-leg on rollers, thus effectually preventing injury or danger from these stresses.

An important and original feature in the general design is that the water-legs are formed by the continuation of the plates of which the shells of the front and rear drums are composed. Thus no flanged plates or riveted seams whatever are exposed either to the fire or hot gases at any point. The value of this form of construction lies in the fact that it eliminates the possibility of the crystallization of plates and rivets and consequent cracks and annoying leaks at the seams arising from overheating and unequal expansion and contraction of double metal thickness, due to exposure to flames and furnace gases of high temperature.



The "Canada" Boiler—Longitudinal Section, Showing Construction.

Another exclusive and very valuable feature of the design is the arrangement for passing the steam, after leaving the vessels containing water, through a series of superheating tubes, wherein it loses every particle of moisture and is heated to a temperature many degrees higher than that normal to its pressure.

No matter how large the boiler, there is only one steam drum, consequently the entire product of the boiler can be piped out of a single steam opening. This means a large saving in the cost of piping.

All parts of the Canada boiler are designed for a safe working pressure of 160 pounds per square inch with a safety factor of more than 5.

CIRCULATION.

From a circulation standpoint one of the most objectionable features of the ordinary type of water-tube boiler is the drum running parallel with the water-tubes, because, since the diameter of this drum is always less than the width of the water-legs, the latter must be drawn inward at the point of junction with the drum, thus forming a throat or opening of contracted area which interrupts the free passage of the water. In the Canada water-tube boiler the drums run crosswise and the throats, or openings, extend the full length of both drums and legs.

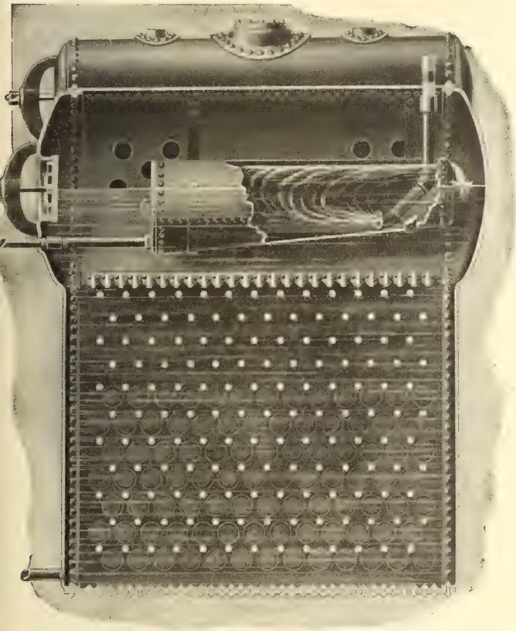
The water is fed into the purifier, whence it overflows into the rear drum and passes down into the rear leg, thence through the inclined tubes to the front leg and upwards into the front drum where the globules of steam generated in the tubes are liberated and carried through the superheating tubes to the steam drum. Meanwhile the water continues its flow through the equalizing tubes to the rear drum, joining the feed current at that point.

The regular movement of all the water in the circuit just described indicates uniform temperature in all the water-tubes, and when an unimpeded circuit has been established in the manner just explained, a maximum supply of dry steam will be delivered. When the circulation is sluggish, the water does not so readily absorb the heat and wet steam and a smaller quantity of it must be expected. It will be noted that while the design of this boiler admits with equal facility the use of either the vertical or the horizontal flame travel, the illustrations herewith show the vertical, it being preferred for several reasons, not the least important of which is that a more uniform distribution of the heat arising from the grates is obtained by first passing the gases upwards through the entire nest of tubes between the front end of the furnace and the first virtical baffle, thence downward between the first and second baffles and finally upward again through the entire nest of tubes between the second baffle and the rear water-leg. It is not difficult to understand that, aside from all other considerations, the course of the heated gases, as descibed, is conducive to more nearly equal division of the units of heat among all the water-carrying tubes than is possible with the horizontal travel which concentrates by far the greatest degree of heat on the lowest tubes during almost their entire length.

SUPERHEATED STEAM.

This valuable product has of late years been the subject of much thought and experiment and now the economical utility of steam containing a number of degrees of superheat is quite generally understood. Ordinary steam at 100 pounds gauge pressure has a normal temperature (omitting fractions) of 338° F., and at 160 pounds its normal temperature is 370° F. The temperature in excess of normal for steam of a given pressure is technically designated superheat. Steam that is in contact with water cannot be heated above the temperature normal to its pressure. The process of snperheating must, therefore, take place subsequent to the passage of the steam from the vessels containing water. Superheat is obtained by exposing steam to gases of higher temperature. The number of degrees of superheat obtainable is governed by the temperature of the gases to which the steam is exposed and the duration of exposure. During various tests under actual working conditions Canada water-tube boilers have produced steam containing from 10 to 30 degrees of superheat.

The first 20 degrees of superheat are relatively more valuable than further superheat, partly because the specific heat of steam appears to be lower nearer the saturation point and partly because the first useful effect of superheat is to counteract the loss due to cylinder condensation resulting from the cooling of surfaces during the emission of exhaust, and also because no matter how little the superheat, at least dry steam in the steam chest of the engine is absolutely assured, which is not possible when merely saturated steam is delivered by the boiler. This type is the only horizontal water-tube boiler in which after the steam has left the drums containing water, it is subjected to gases of higher temperature and absorbs superheat on the way to the steam drum. It will be observed that while the superheating tubes of the Canada boiler are located at a point where the temperature is sufficiently high to afford a very satisfactory degree of superheat, yet they are outside the direct course of the flames and gases from the furnace and there is no danger of overheating the tubes.



The "Canada" Boiler—Section Through Rear Drum and Water-Leg, Showing Purifier, Etc.

All users of steam are familiar with radiation losses in steam pipes and the wastes in engine cylinders due to the fact that at each stroke the new supply of steam is brought into contact with the face of the piston and the internal surfaces of the cylinder, which have been cooled by the exhaust of the previous stroke. When steam is used at normal temperature, each degree of heat thus lost means condensation and a proportional decrease of pressure. When superheated steam is used there is no loss of pressure until the steam is cooled to the temperature normal to the boiler pressure. Thus a tangible saving is effected. The saving is particularly marked if the superheat is secured as in the Canada boiler, by the utilization of heat units which would otherwise pass out through the chimney.

FEED WATER PURIFICATION.

In the Canada boiler the annoyance and inefficiency of the mud drum and the expense of a separate live steam purifier are dispensed with, mud and other scale-forming sediment being very efficiently extracted by passing the feed water through a simple and inexpensive purifying reservoir contained in the boiler itself. This reservoir is in the form of an open-topped semi-cylindrical pan with closed ends, hung loosely by strap-hooks from the shell of the rear water drum, its depth gradually increasing toward the blow-off end. The water is fed into the shallow end and, the pan being large and always full of and surrounded by hot water and steam, it is raised to from 250° to 275° F. before it overflows into the main portion of the drum. The overflow takes place entirely at the shallow end of the pan, the top of that head being one inch lower than the other head and the sides. It is a well-known fact that water begins to clear itself when it reaches a temperature of 200° F., and as the liberal dimensions of the pan allow the water to remain in it a considerable time, practically all the scale-forming impurities are precipitated to the bottom of the pan where they remain in a soft sludge-like state pending the opening of the blow-off valve, the frequency of which would be governed by the character of the water and the rapidity of the accumulation.

It will be noted that aside from its open top, which is several inches above the water line in the boiler, the pan is water-tight. It is entirely practicable, therefore, to blow off the sediment as often as desirable while the boiler is under pressure without fear of reducing the water level below the point of safety.

The purifier in the Canada boiler is self-contained and absolutely independent of the boiler-shell or heads. The pan is made in sections and when it finally deteriorates to an unserviceable point, can be removed and replaced through the manhole with little labor and small expense.

ACCESSIBILITY FOR CLEANING.

The Canada boiler is so constructed that every inch of it is within easy and convenient reach for cleaning, both inside and out. An individual handhole is located opposite each end of each water-tube. The handholes are of the diamond oval shape and each is provided with an accurately fitted plate, held in position by a suitable yoke with bolt and nut, the construction being such that the pressure of the inside of the boiler maintains the tightness of the joint. A distinctive feature is that any one of these plates can be removed and replaced through its own opening without disturbing any of the others.

SETTING AND SUPPORTS.

The setting requires only the most simple and inexpensive masonry, consisting of plain vertical walls and a flat tile roof, supported by the superheating tubes. There is a total absence of troublesome overhanging masonry between or to the drums. The boiler is supported on heavy iron columns and shoes at front and rear, all setting close to the ground and entirely independent of the side walls. Plates and rollers under the shoes at the rear adequately care for longitudinal expansion.

DIRECTION OF FLAME TRAVEL.

The practice of placing a horizontal tile baffle or deflector between the first and second or the second and third rows of tubes above the grates is viewed with apprehension by the boiler inspection and insurance companies, because in this manner the intense heat of the gases in the roof of the furnace is concentrated upon the few tubes below the baffle. The natural outcome of this condition, borne out by the experience of many users, is the premature, and often untimely, destruction of the lower tubes, which means heavy repair bills, if indeed, nothing worse.

Each horizontal row of water-tubes in the Canada boiler is staggered with relation to the rows immediately above and below; in other words, the tubes in one row are located over the spaces between the tubes of the next lower row. The flames and heated gases first strike the lower half of the circumference of the tubes in the first row, thence passing around each of these tubes they are, by means of judicious spacing, impinged simultaneously against the upper half of the circumference of the first row of tubes and the lower half of the second and so on up, then downward and then upward again in like manner through the entire nest of tubes. A higher percentage of heat absorption is obtained by impinging the gases three successive times against the entire circumference of each tube than is possible by simply allowing them to glide along parallel with and only once the length of each tube as in the case of the horizontal baffle. The Canada boiler has no flanged sheets or riveted seams exposed to flames or hot gases when set with either the vertical or the horizontal baffle.

Canada boilers are built in standard units of 100, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450 and 500 horse power, and are, of course, susceptible of battery combinations to reach any desired total.

ELECTRICAL MATTERS IN THE NORTHWEST.

The Canadian General Electric Company have purchased land having a frontage of 80 feet on Notre Dame and Water streets, Winnipeg, and are putting in the foundation for a warehouse 40 x 140 feet. It is expected that the building will be completed this year, when it is the intention to carry a large stock of various products manufactured by the Canadian General Electric Company and the Canada Foundry Company. The company have found it necessary to put another traveller on the road in their Western territory.

The City of Winnipeg has now connected up about 60,000 incandescent lamps and additions are being made so rapidly that new generators will have to be installed shortly to meet the demands of the business, which last year increased by 80 per cent.

The electrical lighting is much more generally used throughout the Northwest than in Eastern Canada. It is estimated that there are in use at the present time one incandescent lamp for each unit of population throughout the Northwest. One reason for the general use of electric lighting is the high cost of coal oil, which sells at about sixty cents per gallon or three times the price prevailing in the Eastern Provinces. What this means will be more fully understood when it is mentioned that the cost of lighting a hotel by lamps in a town of twelve hundred is $75 per month. In addition to the high cost of lighting by this primitive method, there is the danger of fire and the higher insurance rates which in consequence have to be paid on the building. The above mentioned facts make it profitable to install electric lighting plants in towns of much smaller proportions than in the East.

Edmonton recently gave a franchise to a company to construct an electric railway. The company was compelled to place a deposit of ten thousand dollars with the city as a guarantee that at least two miles of the road would be constructed by the first of September. It is learned that as yet no work has been done and that the City will probably keep the deposit and recall the franchises and perhaps undertake the construction and operation of the road as a municipal enterprise.

Mr. Harry Pim, the Canadian General Electric Company's representative in Vancouver, passed through Winnipeg recently on his way to Toronto to consult with the management of the company.

There is a feeling in favor of a meeting of the Canadian Electrical Association in Winnipeg in the near future, and a strong invitation will probably be extended to the Association at its next annual meeting to visit the West at an early date.

SPARKS.

The entire electrical machinery for the plant at Golden, B.C was supplied by the Allis-Chalmers-Bullock Company.

The city of Winnipeg has just taken tenders for the supply of a turbine pump, with electric motor, for the waterworks plant.

The name of Walter Nicholls Motor Boat Company, Limited, Toronto, has been changed to Nicholls Bros., Limited.

The Ontario Power Company,which has developed 60,000 h.p. at Niagara Falls, has made application for permission to supply power in St. Catharines, Ont.

The Eastern Telephone Company have under consideration the extension of their system from Whycocomagh to Port Hood, Mabou and Inverness, N. S.

The Home Correspondence School of Canada, Limited, has been organized with a capital of $40,000 and head office at Toronto. The provisional directors are Messrs. J. K. Brodie, R. A. Rumble and A. G. Slaght.

The Bethesda & Stouffville Telephone Company, Limited, has been incorporated, with a capital of $40,000 and head office at Stouffville, Ont. The provisional directors inclnde Messrs. A. D. Bruce, Robert Miller and George Forester.

The City Council of Guelph, Ont., have accepted the Bell Telephone Company's proposition for a five year extension of their franchise. The company give twenty-two instruments free and a flat rate of $25 per annum for house 'phones.

The Bell Telephone Company are installing a new switchboard at Peterboro, Ont. It is composed of nine sections, three for the long distance and six for the local system. Each section wil accommodate 700 subscribers but can be increased to 1,200. The board is of the central energy type.

One important use for compressed air is in the operation of quarries. Messrs. Kelly Bros., of Winnipeg, have just purchased from Allis-Chalmers-Bullock, Limited, Montreal, six Haeseler pneumatic hammers for dressing stone. These will be operated by an Ingersoll-Sergeant air compressor, Class "E", driven by a 25 h. p. induction motor.

Allis-Chalmers-Bullock, Limited, have removed their Winnipeg office from the B.N.A. Building to 24 Canada Life Building, where they have larger and more convenient quarters. Mr. L. Belnap, the Winnipeg representative, has just returned from a trip to British Columbia. He closed a big deal at Nelson for ransformers, generators, exciters and switchboard, also for the water-wheels and governors, which are of the Escher-Wyss type.

The Jones & Moore Electric Company, of Toronto, ase extending their field of operations, having formed a company in Winnipeg, under the name of The Jones & Moore Electric Company of Manitoba, Limited. The capital stock is $75,000 and the incorporators are Messrs. J. W. Jones, of Toronto, and G. J. Hicks, L. M. Delbridge, J. C. Cavanagh and C. W. Bradshaw, all of Winnipeg.

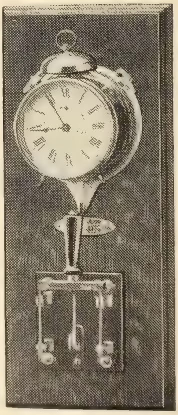
Messrs. A. L. Breithaupt and E. J. Philip, who are connected with the management of the electric light plant at Berlin, Ont., recently visited Chicago, Kansas City and Toledo for the purpose of inspecting gas engines. They reported to the Council that none of the companies manufacturing gas engines would agree to deliver an engine within three months, in view of which they recommended that the present Babcock & Wilcox boiler be repaired and a new 60-inch x 16-foot horizontal tubular boiler installed for gas house work, also that a steam engine be purchased from the Goldie & McCulloch Company, at the price recently quoted. These recommendations have been adopted by the Light Commission. The purchase of an additional gas engine will be considered at a later date and contracts placed in ample time for requirements for next year.

FOR SALE.

An electrical contracting and supply business for sale, town over ten thousand one smaller opposition, will hand over about twelve hundred dollars worth of contracts if sold now. Reason for selling, going into manufacturing. Write for particulars if you mean business. Address Box 38, ELECTRICAL NEWS, Toronto.

B. & W.

- Automatic Time Switch -



Don't waste your current. Let a B. & W. Automatic Time Switch control your window lights and signs. Always on time. Type A turns "off." Type B turns "on" and "off."

Simple--Reliable--Moderate Price

Send for Circular

--Manufactured by--

THE BERLIN ELECTRIC CO., BERLIN, ONT.

ELECTRO MECHANICAL ICE RAKE FOR WATER POWER PLANTS.

One of the questions in the "Question Box" at the recent convention of the Canadian Electrical Association was: "Have any mechanical appliances been found useful in keeping ice off racks in water power plants, thus reducing the large labor bill?" To this Mr. A. A. Dion replied as follows:

The Ottawa Electric Company tried last winter with complete success a power rake designed by Mr. W. H. Baldwin, superintendent of hydraulic works and equipment.

The rake and driving mechanism were mounted upon a truck that travelled on rails parallel to the rack on the top platform close to the edge. The rake was attached to a wooden lever about 5 inches square and 20 feet long. The mechanism driven by a small motor imparted to the lever an up and down motion, causing the rake to scrape the rack from top to bottom and from bottom to top. The lever was so balanced that gravity kept the rake in contact with the rack bars all the time. The pressure of the water also had the same effect. Mr. J. Murphy, superintendent of power houses for the Ottawa Electric Company, furnishes the following description:

Referring to plate herewith:

A is a 2½ h.p. 500 volt D. C. motor.

B is a pulley continuously driven by motor A.

C is a conical friction pulley keyed to the same shaft as pulley B.

DD are cone friction pulleys keyed on a sleeve which is feathered on a shaft E.

E is a shaft connected by gearing to the chain sheave F.

F is a sheave pulley driving a chain which is attached to both ends of a long lever or beam carrying at its lower end the ice rake H.

H is an ice rake made out of a steel plate.

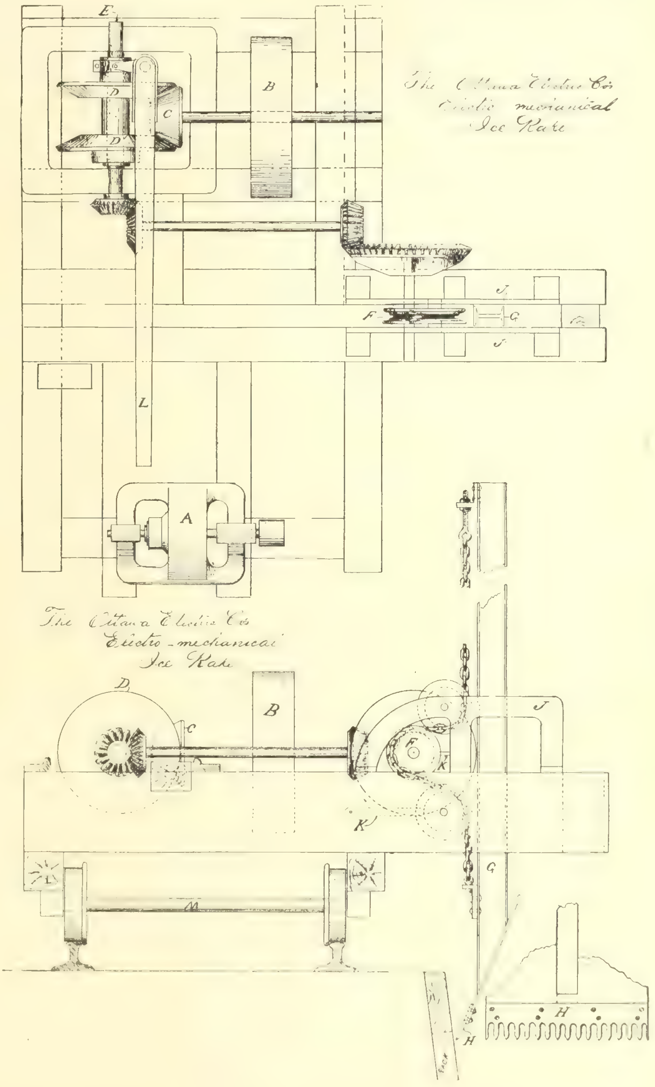
JJ are guides for the rake beam.

KK are knives for scraping the ice off the sheaves.

L is a hand lever for operating the rake by throwing one or the other of the smaller cone pulleys in friction with the larger cone. This causes rake to move up or down as desired.

M is one axle of the truck carrying the whole outfit.

The rake travels up and down at the rate of 100 feet per minute.



TEST OF A SMALL-SIZED GAS PRODUCER AND GAS ENGINE.

The economical possibilities of the small gas engine and producer are well shown in the result of a test recently made on a 50 horse power suction producer, made by R. D. Wood & Co., of Philadelphia, supplying gas to a 36 horse power vertical two-cylinder engine built by the Westinghouse Machine Company, of Pittsburgh, both installed at the Poughkeepsie, N. Y., waterworks. The engine is arranged to drive, by means of a leather belt, a 10 inch volute pump made by the Henry R. Worthington Company, of New York. The interesting figures are as follows: The power developed at the shaft of the engine, 38.8 horse power; pounds of coal consumed per horse power hour, 1.23, and the duty of the entire plant was 89,211,691 foot pounds per 100 pounds of coal fed to the producer. The combined efficiency of the pump and engine as determined from the test of the engine was .557, while the estimated efficiency of the centrifugal pump was .607.

THE TANTALUM INCANDESCENT LAMP.*

By Dr. Louis Bell.

The writer was lucky enough to receive through the courtesy of Mr. E. D. Adams ten twenty-five-Hefner, 110-volt tantalum lamps. These were, with the kind assistance of Professor Puffer, put through various tests, and in particular two of them were given a decay test with the rather startling results recently published in a joint paper. The upshot of the matter was that these two lamps selected as being about the average of the lot in performance, gave a life of some 850 hours before falling below eighty per cent. of their initial candle-power, and were both burning at 16.6 candle power at the end of the 1,190 hours, although one of them had at some unknown time in the previous three days' run broken a filament close to one of the spider arms and had automatically mended itself by the fall of the loose end across the other side of the same loop, where it welded itself firmly into place and went on burning.

These two lamps ran 800 hours of their life at a mean horizontal candle-power of twenty and at about 2.05 watts per candle, thus giving 16,000 candle-hours of useful life at this extremely high efficiency. On a rating of two watts per candle average the lamps were good for 600 hours, giving over 12,000 candle hours. On a rating of 1,000 hours they gave nearly 19,000 candle hours at a mean energy consumption of, say, 2.15 watts per mean horizontal candle. The circuit on which the run was made was on the average fully up to the rated 110 volts, although the pressure varied somewhat irregularly, perhaps a couple of volts on each side of this figure.

The light of the tantalum lamp is, as might be expected from its high efficiency, rather whiter than that of an ordinary incandescent, being as white as the Nernst lamp or the acetylene flame. Its distribution of light is in the present form of filament rather less uniform than of the common incandescent, being relatively more powerful in a horizontal zone and less powerful for points near the axis. The ratio of mean spherical to mean horizontal candle-power, as found in Professor Kennelly's investigation of the frosted lamps, proved to be 0.73, and the writer's figure from the clear lamps was substantially the same. The distribution, however, could very easily be improved, so that the spherical reduction factor would not differ materially from the usual figures and the light at the top could be correspondingly increased.

Since the tantalum filament has a low initial resistance (between fifty-five and sixty ohms) it jumps into incandescence with startling rapidity as compared with a carbon filament, but because of its positive temperature coefficient it seems to be decidedly less sensitive to changes of voltage in its working condition. This is a useful property in certain respects. The fact, however, that the initial resistance of the tantalum is so low and its thermal inertia so small owing to its small mass and low specific heat, means rather violent heating up, which is probably the cause of some doubts which have been expressed as to the endurance of these lamps upon alternating circuits. It is not difficult to imagine pretty severe strains upon the filament if it had time to cool down much between impulses. If such cooling could take place, for instance, on an ordinary alternating circuit, the results might be serious.

Some stroboscopic tests were therefore made at the last moment to determine whether at, say, twenty-five cycles there was a specially violent fluctuation of light from the tantalum lamp ; in other words, to find out whether on a twenty-five-cycle current the filament had time to cool down materially. The result showed that the light fluctuation at this frequency was somewhat but not much more pronounced than in a carbon filament. The tantalum lamp behaved in fact about like a ten-candle-power carbon filament lamp. Even a seventy-five-candle-power carbon filament lamp, however, shows perceptible variation under this test. At sixty cycles the fluctuation, while still perceptible, was trivial both in the tantalum and carbon lamps.

It hardly seems probable that at sixty cycles the life of the tantalum would be enough impaired to cause serious trouble, but the writer now has some lamps on alternating current tests and proposes to pursue the enquiry.

The tantalum filament seems to stretch and sag at first as if undergoing annealing and losing the set produced by drawing, then it shows local bright spots which grow lumpy as if the material intended to flow a little from the heat, and with the increasing lumpiness the filament draws up tight. At this stage it is rather fragile and would probably break easily from vibration or shock. It seems likely that the final break comes just where one of the lumps has reduced the cross section of the wire beside it. The break in the lamp during test, already referred to, shows considerable attenuation of the loose end.

The lamps as tested showed the following characteristics:

Lamp.	Watts.	C. P.	Watts per C. P.
Clear Globes	41.58	21.42	1.94
	38.61	20.90	1.84
	41.58	24.93	1.66
	41.58	21.55	1.93
	41.91	21.81	1.92
	41.91	22.59	1.85
Frosted Globes	40.36	19.79	2.03
	40.04	18.54	2.15
	40.04	18.74	2.13
	40.48	19.27	2.09

The mean result from the clear globes was 22.2 candle-power at 1.85 watts per candle-power, that from the frosted globes 19.08 candle-power at 2.1 watts per candle-power.

It is interesting to note that the clear lamp gives just about one candle-power per inch of incandescent filament, which implies an intrinsic brilliancy of somewhere about 500 candle-power per square inch of filament—a figure much higher than in the ordinary incandescent.

As illuminants the lamps are certainly very excellent, but their introduction raises some most interesting questions for the central station operator.

Putting aside all the petty questions that will be raised about the new lamps for commercial reasons, the broad fact remains that we are here dealing with a bona fide two-watt lamp having a life fairly comparable with the carbon filament lamps now customarily in use. Moreover, it is a competitor of these socket by socket, and not as a substitute with particular requirements as in the case of the Nernst lamp or the very small arcs. There is some doubt as to the life of the tantalum lamp when exposed to unusual vibration, which may perhaps bar it in some special locations, but for the every-day work of the central station there is good reason to believe it generally applicable.

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* Paper read before the National Electric Light Association.

Its price can hardly be said to be fixed in this country, but abroad in Berlin it is about one dollar (M. 4), which will give at least a fair line on its commercial results. On this basis and with current at ten cents per kilowatt-hour one finds, taking the new lamp on its 600-hour rating, that the cost of its 12,000 candle-hours, including the lamp, amounts to $3.40. The same number of candle-hours from a lamp giving a mean efficiency of 3.25 watts per candle would cost $3.90, exclusive of lamps ; i.e., the consumer could afford to pay $1 for the new lamp better than to take the old ones free. With current as low as five cents per kilowatt-hour, the user of tantalum lamps could only afford to pay seventy-five cents per lamp as against getting carbon lamps free. That means that a sliding scale of discounts for lamps according to quantity could be made to catch the consumer at all prices ordinarily charged for current by central stations. Does this mean that the carbon lamp will shortly be down and out ? Probably not, for there is no spur like competition to start up improvements, and there are some signs that carbon lamps may be improved enough in efficiency to make things interesting at least with current at the prices charged to very large consumers. This, however, remains to be seen, and the thing which the central station man has to meet is the immediate probability of consumers putting upon their circuits lamps taking less than two-thirds the energy per candle-power of the best lamps now in use and thereby cutting down their meter bills enormously. Now, broadly, what shall be the attitude of the central station man toward this income scalping innovation? There are some managers who may be inclined to put up a fight to discourage the user, either by raising pettifogging objections or by trying to discriminate against two-watt lamps by readjusting discounts in various ingenious ways. The writer is very strongly of the opinion that such a policy is wrong and will certainly lead to ultimate disaster in the form of municipal restrictions or regulation of rates by law. In the long run, opposition to improvements does not pay. If, on the other hand, the central station man hangs quietly on and gives the consumer the glad hand, the change will work to his ultimate benefit. In the first place, the tantalum lamps now made are of twenty-two candle power instead of sixteen and the filament will hardly bear much reduction in cross section. The tendency therefore will be to use these slightly more powerful lamps taking, say, forty-two watts instead of a trifle over fifty watts in the sixteen candle-power carbon lamps. The actual loss in energy sold is likely therefore to be for the present quite a little less than the difference of efficiency would indicate.

Besides this, the attraction of cheaper light will certainly bring into line new consumers, so that the net result will probably be an actual increase in sales of current, quite a little of it being among the smaller consumers who pay the higher rates. Such a change means on the whole more lights connected per unit of capacity in transformers or feeders, and hence a slightly better utilization of material and improved load. In the case of stations with underground service, the change to two watt lamps ought to bring with it increased earnings per unit of cable capacity. The fact is that improvements in the efficiency of utilization of electric energy help the business and it is both fruitless and inadvisable to oppose them for any short-sighted notion of small temporary savings.

I have here said nothing regarding the inevitable competition between present lamps and the newcomer. In the first place, the merits of the final issue remain to be determined, and in the second place competition in lamps is on the whole a good thing for the user of them however it turns out. So far as the central station is concerned, it is a case of dog eat dog.

The really important thing is that from now on the station manager will have to deal directly with the two watt lamp proposition, for there is no disguising the fact that it is here, and in a form quite unexpected. The appearance of tantalum lamps in quantity may be a little delayed in this country, but delay will improve them as is the case with every new product, and will serve to assure a better understanding of their truly remarkable properties and of their possible limitations. The unexpected has certainly happened, for most engineers had long ago abandoned the idea of a lamp with a metallic filament. Only the discovery of a metal virtually new, and possessed of some sensational qualities, could have brought about the present striking result.

A COMPLETE ELECTRIC KITCHEN.

The Niagara Construction Company, Limited, of Niagara Falls, Ontario, have placed with the Prometheus Elertric Company, 39 Cortlandt street,, New York city, an order for a complete electric kitchen sufficiently large to prepare meals for fifty persons, and which will be used on the occasion of the opening ot the new power station of the Ontario Power Company.

The equipment consists of an angle-iron table eighteen feet long, on which are mounted three five-gallon urns, with inner vessels for milk, coffee and hot-water; one oven capable of taking twenty-five pound roasts or the equivalent; two large copper vessels for boiled dinners; three twelve-inch by thirteen inch broilers; one plate-warmer forty five inches by sixteen inches by thirty inches ; and one steam table five feet long by two feet wide, designed to take four food compartments.

The total outfit is designed for a consumption of twenty-seven kilowatts, and the output will be controlled separately by means of switches and keys.

A STREET RAILWAY FRANCHISE.

Under the agreement made between the Town of Galt and the Grand Valley Railway the new railway is allowed to come into the town, but it must maintain the streets it traverses ; it must water them ; it must give running rights to any other road desiring to use them ; it must sell to the corporation at the expiration of the franchise, which is limited ; it is under a penalty of $50 a day for non-fulfilment of contract. The new road runs from Brantford ; Galt has already allowed one trolley line to enter, namely, the one from Preston and Hespeler ; so that the town has solved the question of the entrance of suburban lines ; it lets them in and compels interchange in use of rails on fair terms, one company of the other.

LINES, WIRES, CABLES AND TESTING.

(From Canadian Electrical Association Question Box).

Q. Is there any law for height of wires strung above streets?

All Dominion charters granted to telegraph and telephone companies clearly stipulate that wires shall not be less than twenty two (22) feet above the street level. The Railway Act of 1903, Section 195, states "The company shall not permit any wire to be less than twenty two feet above highway or public place." I do not know of any municipal ordinance regulating the height of wires above roadways, but would consider twenty-two feet to be the legal limit.—A. B. SMITH, Toronto.

We have a municipal by-law here to the effect that wires must be not less than twenty feet from the ground.—A. SANGSTER, Sherbrooke, Que.

No general law. Some companies are limited to 22 feet.—J. J. WRIGHT, Toronto.

Yes. Municipalities and Provinces have laws regarding height of wires—generally 22 feet—and many regulate height of poles.—J. F. H. WYSE, Toronto.

Q.—Has a contractor a legal right to move a tall building down a street where wires are strung and order the Lighting Co. to take their wires down, or to pull them down if the Company refuses to comply? If the Lighting Co. takes the wires down should the contractor pay for trouble and expense?

It depends on the franchise granted the lighting company. It may be assumed that both the lighting company and the house mover have a right to use a street, but neither of them an exclusive right. It should be easily a matter of arrangement and if the lighting company moves its wires to accommodate the house mover, the latter should bear the expense of the removal, provided that it is a reasonable one.—J. J. WRIGHT, Toronto.

The Contractor should have the right to move the building on the street. The Electric Co. must remove and replace the wires at the expense of the Contractor. —ROBERT J. SMITH, Perth, Ont.

This depends upon local by-laws. Ordinarily a civic permit is issued after all arrangements to move building have been made. The Contractor has no right to interfere with public wires in streets. The Contractor may have to pay for expenses of making way for building to pass, if there is expense caused to Lighting Co., unless the wires can be guarded by the regular patrol of the company.—J. A. DOUGLAS, Winnipeg.

The contractor must use the streets as he finds them. The lighting company's wires occupy the street legally and if any change is required it should be ordered by the City and paid for by the Contractor. Mutual concessions are always advisable in such cases.—A. A. DION, Ottawa.

No legal right. Certainly the contractor should pay for this trouble and expense. Of course, in some instances policy and diplomacy may dictate making no charge for this accommodation, but then, as with any other concession, it should be regarded as a favor from the Company.—J. F. H. WYSE, Toronto.

Q.—Is it advisable to transpose a 3-wire, two-phase, 133 cycle, 2400 volt transmission line about four miles long, operating an inductive motor load in the day time? If so, how often and in what manner?

Yes, every six poles seems to be about the proper distance.—ROBERT J. SMITH, Perth, Ont.

Have found good results from transposing once in this distance, by crossing the outside wires.—J. F. H. WYSE, Toronto.

Q.—What is the best method of cleaning joints on a transmission line preparatory to soldering them. The line is a bare one and has been up for some years, but the joints were never soldered?

Under the conditions mentioned, the only proper way seems to be to cut out joints and put in new ones, or put in jumpers soldered on either side of the old joint. Cleaning with zinc and sulphuric acid is effective, but the corrosion due to the acid not evaporated by the solder remaining in the joint makes it bad.—J. F. H. WYSE, Toronto.

Q.—In a series alternating current arc circuit, is it necessary to bring the return wire back to the station parallel with the outgoing wire on the same pole line, or can the circuit encircle a large area without involving excessive inductive drop?

Do not consider it neccessary to bring the wire back to the station parallel with the outgoing wire, though this is generally done where the station is located somewhat "out of town."—J. F. H. WYSE, Toronto.

In series A. C. arc circuits, if the wire encircles a large area an inductive drop will evidently be encountered. The inductance of the circuit does not, however, increase as the distance apart of the wires are increased. As an example, a No. 6 B & S wire arc circuit carrying 6·6 amperes, wires 12 inches apart, 60 cycles, will show a reactive drop per mile of 8.4 volts. If the wires are placed 200 feet apart, that is over 16 times the previous distance, the inductive drop would be increased only 3½ times. It seems, however, that the greatest trouble that would be experienced, if the return wire is not built back on the same pole, is the inductive effect of the loop so formed on telephone circuits.—L. A. Herdt, Montreal.

It is not neccessary to bring the return wire of a series alternating arc circuit back parallel with the outgoing wire on the same pole line. The difference in the percentage inductive drop will not be excessive. If such a condition were essential to operation it would remove, in a measure, one of the greatest claims in the series system, viz., the simplicity of running a wire from lamp to lamp without respect to the route covered by the out-going circut.—R. T. MACKEEN, Toronto.

Q.—What is the smallest wire safe to use in street lines, having regard to tensile strength?

Our experience is that anything less than No. 6 B. & S. has not sufficient mechanical strength.—LOUIS W. PRATT, Brantford, Ont.

It is not advisable to use a wire smaller than No. 8 B. & S. gauge for street service.—R. T. MACKEEN, Toronto.

No. 6 B. & S. for insualted copper wire.—A. A. DION, Ottawa.

No. 6 B. & S. medium drawn (a good deal of 8 is used).—J. F. H. WYSE, Toronto.

Q.—Why is double braided weatherproof wire usea *almost exclusively in Canada when triple braid is the rule in the United States ?*

I don't know, but I suppose it is on account of lower price. Some engineers advocate bare wires in city streets. If weatherproof insulation is of any use on 2,000 volt circuits, and I think it is, triple braided wire should be used.—A. A. Dion, Ottawa.

Probably from the habit of specifyng D.B.—J. F. H. Wyse, Toronto.

Q.—Why is a transmission cable made of six wires over a hemp centre preferred, by some engineers, to all copper cable ?

The use of a copper wire centre for a copper cable is very objectionable, due to the fact that the moment any strain comes on the cable, this strain is assumed almost entirely by the copper wire centre, with the result that it is elongated to a point where the cross-section and strength are materially reduced, or in some cases, until rupture occurs. This is due to the fact that the outer conductors of the cable are wound spirally and hence possess in a measure the properties of a spring. The result is that it can be elongated very much more upon the application of tension than is possible with the solid conductor. A hemp centre is more elastic, and hence is free from the objections of the solid wire centre, and apart from the question of conductivity furnishes a substantial core upon which to wind the cable. It is also of considerable strength, and doubtless adds materially to the total strength of the cable. In this case, however, the whole tension is practically taken by the copper conductors.—R. T. MacKeen, Toronto.

To have a common centre to strand wires on and to give even tension on all wires, hemp centers are used in steel cables for transmission of power and for cable cars ; they make they cable more flexible and do away with wear in the centre. If a centre strand of wire it would have no flexibility.---J. F. H. Wyse, Toronto.

Q.—What should be the cross section of each strand in a copper cable, consisting of 61 strands, in order that the resistance of such a cable would be exactly equal the resistance of a solid copper bar having a cross section of 500,000 circular mils; it being necessary, of course, that the 61 conductors be twisted together to form the cable ; thus each strand follows a long spiral course ?

If strands are insulated from each other, additional length caused by twist of strands should be taken into consideration; if bare, the sum of the cross-section areas may be considered as the cross-section of the cable.— J. F. H. Wyse, Toronto.

Q.—In 2200 volt sub-station wiring, is twin conductor, lead covered cable, in iron conduit, objectionable ?

No. On the contrary it should be most satisfactory, though it is as a rule desirable to either line the conduit or cover the lead with some insulating substance so as to prevent the flow of local currents which might destroy the lead.—A. B. Lambe, Toronto.

Not with proper insulation and with iron conduit thoroughly grounded, but would prefer vitrified conduit.—J. F. H. Wyse, Toronto.

There is not the slightest objection to using twin conductor lead-covered cables in iron conduits, providing the twin conductors are used as out-going and incoming circuits, for any alternating current voltage for which the makers will guarantee the dielectric strength of the cable.—R. T. MacKeen, Toronto.

No; that is, if the conductors will stand a 10,000 volts test between the conductors and between each conductor and the lead sheathing.—Em. Mavaut, Ottawa.

Q.—Where Central Station Companies do not go in for house wiring, what means is there to enforce proper wiring?

They must have a wiring inspector.—J. A. Douglas, Winnipeg.

They must make inspection and insist on safe wiring, but if they insist on the letter of the underwriters' rules they will lose business. Where there is keen competition nothing can be enforced. It is better to use gentle persuasion, to make it appear to the prospective customer that you are acting in his own interest.—A. A. Dion, Ottawa.

Have rigid inspection of all house wiring by the Central Station Company before connecting to your circuit.—Robert J. Smith, Perth, Ont.

The plan of withholding connection until the wiremen furnish a certificate from the local inspector of the Canadian Fire Underwriters Association is the best means we know of, and works out very nicely.—Louis W. Pratt, Brantford, Ont.

Insist on certificate by Inspector of Canadian Fire Underwriters Association before connecting up.—J. F. H. Wyse, Toronto.

Q.—What is the best method of testing arc circuits for continuity, grounds, lamps out, etc?

We use an old 1100-110 volt transformer for testing purposes. Its low tension coil is connected to a 55 volt A.C. circuit and consequently 550 volts is obtained from the other coil. Call the two 550 volts leads A and B. In lead A six 100 volt 16 c.p. lamps are inserted in series. Lead B is tapped near the transformer to a permanent ground connection. The two leads are provided with insulated handles. The lamps are mounted in a prominent position on the switchboard. Each series arc circuit is subjected to following tests at stated intervals during the day time, all circuits being open at the station. (a) Lead B is applied to each terminal of every circuit to ascertain if the circuits are clear of "live" crosses. (b) Lead A is applied as above to test for "grounds." (c) Leads A and B are applied simultaneously to the two ends of each circuit to see that an "open" circuit does not exist.—J. Murphy, Ottawa.

For continuity—a visible lamp detector burning continuously at, say, 110 volts. This will not interfere with trimming. Connect one lamp to each line and one relay and gong to ground at station. Use 52 v. lamps. This when arc current is off.—J. A. Douglas, Winnipeg.

Depends on the system.—J. F. H. Wyse, Toronto.

Q. How is an "open circuit," or the point of the break, in an arc circuit located :—

(a) *In the daytime?*

(b) *At night when running.*

Each of our arc circuits is provided with one or more absolute cut-outs. Troubles are localized by means of the cut-outs and then traced up by the patrolmen.—J. Murphy, Ottawa.

(a) By magnets. (b) By putting circuit on low voltage.—J. F. H. Wyse, Toronto.

ENGINEERING and MECHANICS

CONVENTION OF STATIONARY ENGINEERS.

The sixteenth annual convention of the Canadian Association of Stationary Engineers was opened at Chatham, Ont., on August 22nd, with F. J. A. Sculthorpe, of Hamilton, in the chair. The Mayor being unable to be present, an address of welcome was delivered by Mr. Kelley.

The President then read his address, as follows:

PRESIDENT'S ADDRESS.

Brethren: I have the honor and pleasure of welcoming you to this our sixteenth annual convention. I believe that in selecting you as delegates from the various branches the members have sent their best men. I hope your deliberations will result in the advancement of our organization and that in dealing with the various subjects brought before you the one and only aim shall be the greater good of the C.A.S.E. I need not ask for your hearty support, as this has always been given to the occupant of the chair.

I am sorry to say we have not inceased in membership as rapidly as we might have. There is no doubt we have some of the best engineers in the Dominion in our Association, but we must admit there are many good engineers who are not as yet members of our Association, and I do hope (Clause 1), That the Ways and Means Committee will suggest some plan to interest these men and show them that it is to their advantage as well as ours to throw in their lot with us, and that we are banded together not only for the benefit of ourselves, but also for theirs, our employers, and the safety of the public at large.

I am glad to see that the manufacturers of Canada realize the fact that it is to their benefit to have their engineers members of our Association. (Clause 2) I strongly recommend that a Legislative Committee be appointed from this body to work in conjunction with the O.A.S.E. to draft a new bill and to see that same be presented at the next session. Your Legislative Committee this year put forth their best endeavor for the license law. We had joint meetings with the O.A.S.E. and interviews with several Ministers. (Clause 3) At our last convention it was decided to change the name of this Association from Stationary to Steam Engineers. I would recommend that this be again reconsidered by you. (Clause 4). It was also decided to issue a certificate of membership; nothing having been done in this matter I would recommend that this be reconsidered. (Clause 5) I would recommend that steps be taken so that any delegate may be eligible for any position in the gift of this convention. (Clause 6) I would also recommend that any British subject who is duly qualified may be eligible for membership in this Association without further residence in the Dominion, and that Article 3 Section 1 be amended to read as follows:

"This Association shall be composed of practical engineers who are residents of Canada or who are British subjects of good moral character and who have a practical knowledge of steam engineering, which shall be determined by an examination, with not less than three years experience.

In conclusion, I desire to express to you my deep sense of gratitude for the great honor you conferred on me, a year ago, when you elected me to the high and honorable position of President of this Association and for the loyal manner in which you have stood by me. I will only add that it is my heartfelt wish that your deliberations at this convention may be so conducted toward each other that everything we shall do will be for the benefit and honor of our good Association.

F. J. A. SCULTHORPE, President.

The minutes of the previous convention were then read by Secretary Inglis and adopted.

The Secretary then read his report, which made the following recommendations:

First. The institution of a sick benefit fund controlled by the Executive.

Second. The appointment of a Board of Examiners to grant certificates to competent engineers.

Third. That the per diem pay during convention be cancelled so as to give the Executive more funds to work on.

The Secretary's report further said: "During the past session of the Ontario Legislature a committee of stationary engineers applied for a license bill, but failed. I am led to believe that we will never get the bill passed till stationary engineers in all parts of the province unite in more faithful work in its interests.

"Re membership, I regret that we have not organized any new branches this year, but all the other lodges have made progress and retained their membership. The correspondence during the year has been large, with many enquiries regarding our organization generally."

The President's address and the Secretary's report were referred to the Committee on the Good of the Order.

The President then appointed a Striking Committee, who selected the following as members of the different standing committees:—Good of the Order—Bros. Moseley, Wickens, Sweet, Outhwaite, and Kelley. Ways and Means — Bros. Ironsides, McGhie and Crockett. Auditing — Bros. Steeper and Stubbs. Mileage — Bros. Grandbois, Trott and Hughes.

Bro. Inglis gave notice of motion that the word "Stationary" be substituted for the word "Steam" in the name of the Association. Upon motion of Bro. Moseley, it was decided to rescind the present preamble and insert the original preamble of the Association. The convention then adjourned until 2 p. m., and upon resuming Bro. Wickens reviewed the attempts which had been made to secure a license law from the Ontario Legislature. Last year action in this direction was taken by a joint committee composed of members of the Canadian and Ontario Associations of Stationary Engineers and the International Union of Steam Engineers. Unfortunately, the same bill which had been defeated the year before was presented to the Legislature, with the result that it was strongly opposed by the Canadian Manufacturers' Association. During the discussion which followed Mr. Wickens' remarks it was stated that the bill had received no opposition from the Boiler Insurance companies or their inspectors. The bill was thrown out in committee and did not reach the House. Upon motion of Bro. Inglis, a committee was appointed to act in conjunction with the O.A.S.E. to prepare a bill to be presented at the next session of the Legislature. An editorial which appeared in the Canadian Engineer condemning the license bill was the subject of considerable discussion. It was pointed out that the fundamental principles of higher education had been attacked, and a committee was appointed to write a suitable reply to the article.

The question of issuing a handbook was considered, a proposition to that end having been submitted by the publishers of The Engineering Journal. A committee, consisting of Bros. McGhie, Crockett, Ironsides, Inglis, Sweet and Moseley, was named to prepare a series of papers to be distributed to the members during the coming winter. Business was then suspended and the delegates were given a ride around the city. The works of the Chatham Gas Company, where a very interesting plant is in operation, and of the Chatham Wagon Company, were visited. Mr. W. W. Scame, dealer in oils and engineers' supplies, took the party down the river in his gasoline launch, and in the evening the convention again resumed. A motion to cut off the per diem allowance to delegates when a convention was held in their city was defeated. The reports of the Auditing Committee and of the Mileage Committee were received and adopted. A letter of condolence was ordered to be sent to Bro. Dixon in view of the recent death of his daughter. Bros. Moseley, Outhwaite, Sweet, Cornish and Wickens were appointed a committee to prepare three papers for the next convention.

SECOND DAY.

The first order of business on Wednesday morning was the election of officers, which resulted as follows: President, W. A. Sweet, Hamilton ; vice-president, Joseph Ironsides, Hamilton ; secretary, W. Outhwaite, Toronto ; treasurer, J. M. Dixon, Toronto ; conductor, E. Grandbois, Chatham ; door-keeper, Charles Kelley, Chatham.

Mr. B. F. Uttley, of the Goldie & McCulloch Company, extended an invitation to the Association to hold their next annual convention in Galt. This met with the approval of the convention and the secretary was instructed to communicate a vote of thanks to the Goldie & McCulloch Company for their invitation. Bro. Wickens will take steps to form a branch in Galt, where there are a large number of engineers.

The Committee on the Good of the Order then submitted their report, in which they recommended that Clauses 2 and 3 of the president's address be adopted; that Clause 4 be not adopted ; that Clause 5 be amended to read "No person is eligible for election to the office of Executive President unless he is a past president of a subordinate lodge ; that Clause 6 be amended as follows: "Sec. 1, Art. 3. This Association shall be composed of practical stationary engineers who are residents of Canada, or are British subjects, of good moral character, and who have a practical knowledge of stationary engineering, which shall be determined by an examination, and not less than two years experience, and to be a resident of the jurisdiction not less than six months, or to possess an O.A.S.E. certificate"; that the offer of "The Engineering Journal" be accepted, provided that a member of the C.A.S.E. be appointed one of the judges ; that Article 12, Section 1, be amended to read "Any day after the first Tuesday in August at the call of the President" ; that the following be incorporated in the preamble : "This Association shall at no time be used for the furtherance of strikes or in any way interfere between members and their employers in regard to wages, recognizing the identity of interests between employer and employees and not countenancing any project or enterprise that will interfere with perfect harmony between them. Neither shall it be used for political or religious purposes. Its meetings shall be devoted to educational, professional and mechanical knowledge."

The report was adopted as submitted. In the afternoon votes of thanks were tendered to the Mayor and Council, the local committee, the press, and to Bro. Inglis for the energy displayed in his position as secretary. Mr. H. G. Skelsey was appointed assistant secretary and official stenographer of the C.A.S.E.

The report was adopted as submitted.

The convention then adjourned to meet in Galt next year.

THE BANQUET.

The annual dinner was held at the Hotel Garner on Tuesday evening. After the menu had received due attention, responses were made to the following toasts: "The King", by singing the National Anthem;"Canada Our Home", by A. B. McCoig, M.P.P., H.S.Clements, M.P., and W. Crockett; "The Maple City", by Ald. Westman and W. W. Scane; "Mayor and Council", by Mayor Cowan and Ald. Marshall; "Executive Head and Delegates", by Bros. Wickens and Moseley; "Sister Associations", by Mr. F. B. Uttley and Bro. Sculthorpe; "Manufacturing Interests of Canada", by W. H. Stevens and W. R. Lannan; "The Ladies", by W. Piggott and J. W. Edmundson; "The Local Association", E. Grandbois, F. F. Hayes and Charles Kelley, "The Press", by S. Groves and A. Thibadeau; "Host and Hostess", by Mr. Eberts. A very pleasant evening was concluded by the singing of Auld Lang Syne.

The supply men present included Mr. E. Irving, of the Sunbeam Incandescent Lamp Company, Toronto; Mr. O. V. Philips, of the Canadian Oil Company, Toronto; Mr. E. H. Hughes, of the H. W. Johns-Mannville Company, New York, and Mr. F. B. Uttley, of the Goldie & McCulloch Company, Galt.

ELECTRICAL MOTORS VS. SHAFTING.

It is claimed, with good reason, that the use of motors on each machine, instead of transmitting energy by belting and shafting, will save a large percentage.

The advantages presenting themselves are the following : 1, Less costly and more conveniently arranged buildings ; 2, immunity from interruptions due to the necessity of shutting down the whole plant on account of any section being out of order ; 3, more economical steam plants ; freedom from danger and obstruction of shafting and belting ; 4, a very large saving in shafting and belting ; and 5, the absolute unimportance of the relative position of the power plant and the mill. In each case the locations are determined by the most economical position of power plant, to enable it to obtain water for steam and condensing purposes, and of the mill for the most convenient situation for the railways and to find inexpensive foundations. Power can be distributed across streams, up or down hills, around corners, up or down stairs with ease.

Friction clutches, belts, shafting, pulleys, are all done away with. The motors may be attached to the individual machine, or located under or over as may be desired.

There is a saving in the friction alone of 20 per cent. The producing capacity of the machinery operated is, in actual practice, increased about 4 per cent., due to the steadiness in this method of driving over the usual method of ropes and belts, and the more uniform speed obtained throughout the plant. The enormous flexibility and economic problems solved by the installation of these electric-driven cotton mills are felt even outside the mill itself.—The Economist.

Mr. W. J. Clark has started in business as an electrical contractor at Stratford, Ont. He will undertake complete light and power installations and intends to make a specialty of window lighting signs and flashes.

THE CANADIAN NATIONAL EXHIBITION.

The Canadian National Exhibition at Toronto, which closed on the 9th inst., was without doubt the most successful ever held. Progress was shown in the number and character of the exhibits, while the attendance far exceeded any previous Exhibition, which was due in part no doubt to the exceptionally favorable weather. About the usual number of exhibitors were to be found in the Machinery Hall, but it is to be regretted that there was not a large representation of the manufacturers of electrical apparatus.

The Canadian General Electric Company and the Canada Foundry Company again occupied a large space. On the north side of the building was a C.G.E. 170 ampere 500 volts direct-current generator operating the motors in the Process Building and driven by a Goldie & McCulloch 80 h. p. Wheelock engine. In their regular space to the left of the main entrance were four 4000 volt alternating current transformers furnishing arc light for the exhibition buildings, also a range of products manufactured by the Canada Foundry Company, including a Canada water tube boiler, an Underwriter's fire pump 20x12x16 of a capacity of 1,500 gallons per minute, Northey pumps, "Easy" injectors, hydrants, valves, architectural iron work, etc.

The feature of the United Electric Company's exhibit was a 50 h. p. "Hoffman" rotary engine driving a direct current "Johnson" generator. This engine, of which a description will be published in a later issue, is now being manufactured in Canada by Johnson & Hoffman. Direct and alternating current generators and motors, switchboard equipment, arc lamps, etc., completed the exhibit.

The Jones & Moore Electric Company, Toronto, had their usual attractive display, including bipolar and multipolar generators and motors, Adams Bagnall arc lamps and a complete marble switchboard with ammeters, voltmeters, pilot lamps, controllers, etc.

The Toronto & Hamilton Electric Company, Hamilton, and the Consolidated Electric Company, of Toronto, each exhibited a line of direct-current generators and motors, as well as switchboard instruments and electrical supplies in general.

H. H. Watts & Company, Toronto, exhibited electrical and steam specialties, including a current interrupter, push buttons, the "Globe" dry battery manufactured by the National Carbon Company, Cleveland, and the "Paradox" gas engine. In the exhibit of the Central Electric and School Supply Company were to be seen many interesting articles such as electric clocks, flash lights, etc. They handle the Columbia dry cell, which is specially designed for telephones, street car signals, fire alarm systems and motor cars.

The Canada Metal Company, Toronto, had a splendid display of babbitt metals, electrical zincs, fuse wire, copper, pig lead, etc.

J. N. Tallman & Sons, Hamilton, showed a general line of "Arctic" anti-friction babbitt metal, ingot copper, pig-lead, antimony, and machinery and ornamental brass, as well as Tallman's white bearing metal, which they are just placing on the market.

Babcock & Wilcox, Limited, Montreal and Toronto, again exhibited a large water tube boiler equipped with the B. & W. superheater, which they claim to be a large saver of coal.

A very complete range of power transmission appliances was shown by the Dodge Manufacturing Company, Toronto, including wood split pulleys in operation, couplings, hangers, self-oiling bearings and the Dodge car puller, which has a capacity of from five to eight cars.

Bearings were exhibited by four firms, namely, Henderson Roller Bearing Company, Toronto; Chapman Double Ball Bearing Company, Toronto; Canadian Bearings, Hamilton; and Brintnell Adjustable Roller Bearing Company, Toronto.

Gas and gasoline engines were shown by Gould, Shapley & Muir, Brantford; Georgian Bay Engineering Works, Midland, and the Canadian Fairbanks Company. The Fairbanks display also included steam and power pumps, valves, scales, wood split pulleys, belting and several other lines.

The exhibitors of belting and mill supplies were the Dominion Belting Company, Hamilton, and D. K. McLaren, Montreal, the former showing their "Maple Leaf" brand of cotton duck belting and the latter their well-known oak tanned leather belting.

The Jones underfeed mechanical stokers were to be seen in actual operation in the boiler room adjoining the Machinery Hall.

One of the most artistic exhibits was that of the James Morrison Brass Manufacturing Company, Toronto. Besides the wide range of brass goods which they manufacture, they showed the J.M.T. injectors, Nethery flush valves, ship telegraph gongs, etc.

Other exhibitors included S. E. Bowser & Company, Fort Wayne, Ind., patentees of the Bowser system of oil storage; Eureka Mineral Wool Company, Toronto, mineral wool, Paroid roofing, etc.; Philip Carey Manufacturing Company, Toronto, asbestos pipe covering, Magnesia cement roofing, and asbestos sheeting; Garlock Packing Company, Hamilton, packings and asbestos pipe coverings; and Simplex Engine Company, Toronto.

Upwards of 200 Adams-Bagnall series alternating arc lamps were used for lighting the different buildings. These were supplied by the R. E. T. Pringle Company, of Montreal, through their Toronto office.

ELECTRIC MINING APPARATUS.

The Granby Consolidated Mining, Smelting and Power Company, of Grand Forks, B.C., are adding some electrical machinery to their plant. The machinery includes one 300 h.p. motor, 3 phase, 400 volt, 60 cycles, 3 bearing; three 150 h.p. motors, 3 phase, 400 volts, 60 cycles, 2 bearing; two electric locomotives, 220 volts, 20 inch gauge, and one 75 h.p. 3 phase 400 volt, 1120 r.p.m.; 60 cycle induction motor, operating in a water tight case for mine pumping service. The whole apparatus was purchased from the Canadian Westinghouse Company at Vancouver. The installing of the machines was done under the supervision of Chief Electrician Laine, of the Granby Consolidated Mining, Smelting and Power Company.

The North River Power Company, Limited, Montreal, has been incorporated, with a capital stock of $90,000, the incorporators being Messrs. Robert Bickerdike, Albert Fogarty, J. A. Mann, and W. R. Stavely, of Montreal, and Hugh W. Robertson, of St. Andrews, Que. The company is given power to acquire the business of The Shelby Company and to manufacture apparatus for the development of electrical, hydraulic and steam power.

SPARKS.

The Andover and Perth Electric Light Company, of Andover, N. B., are offering for sale their power site at Four Falls.

The citizens of Palmerston, Ont., have approved of an expenditure of $3,000 to improve the electric light plant.

The electric light plant at Pictou, N. S., will likely be duplicated, a meeting of the ratepayers having been called to consider the question.

An electrician employed by the village of Fort Frances, Ont., has reported that an electric light plant could be installed for lighting the streets at a cost of about $8,000.

Mr. W. C. P. Heathcote has completed the surveys for the proposed extension of the Peterboro street railway to Young's Point It is understood that the cost is estimated at $250,000.

It is rumored that the Southwestern Traction Company, which is now building an electric railway from St. Thomas to London, will continue the line to Hamilton and probably to the Niagara frontier.

The Maine & New Brunswick Electric Power Company have closed a fifteen year contract for the furnishing of light and power to the town of Houlton, Maine, and engineers are now preparing plans and specifications for developing the power of the Aroostook Falls, which is estimated at 3,000 h. p. Messrs. J. E. Stewart, J. W. Niles and G. G. Porter, of Perth, N. B., are interested.

The St. John Street Railway Company are extending their lighting system into Carleton, a suburb of St. John, N. B. This the Carleton Electric Light Company propose to combat. They are now preparing to supply additional light and will apply for the contract for street lighting, which expires in two years. It is probable that the outcome of the present situation will be that the St. John Railway Company will purchase the plant of the Carleton Electric Light Company.

The Kensington-Brandon Development Company, of which Mr. Currie, of Toronto, is vice-president, may establish a street railway system at Brandon, Man.

The Brantford Electric & Operating Company, Brantford, Ont., have decided to proceed with the installation of a new steam plant.

Mr. Charles Barber, manufacturer of water wheels, Meaford, Ont., calls attention in an exchange to the water power of the Sauble river. The volume of water is about 6,000 cubic feet per minute, and he estimates the available head at 22 feet, representing a constant 200 horse power ; as the reservoir is large, it is probable that a 400 horse power plant could be installed with perfect safety. The falls are only about seven miles from Wiarton, and are owned by Mr. John Thede. The development of the power for transmission to Wiarton is being agitated.

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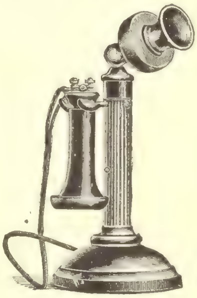

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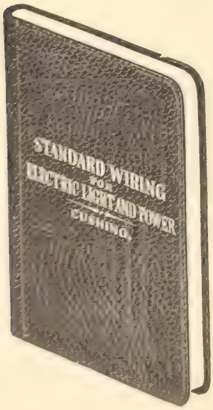

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SPARKS.

The citizens of Ladysmith, B.C., have determined to proceed with the scheme to secure an electric lighting system.

Mr. Willis Chipman, C.E., of Toronto, has been engaged to design waterworks and electric light systems for the corporation of Dalhousie, N.B.

The Ottawa Electric Company are installing a 1,500 k. w. steam turbine from the works of the Westinghouse Company. It is of the Westinghouse-Parsons type. The Canadian Westinghouse Company have installed smaller turbines of the same type for the Northern Electric Company, Montreal, Belleville Portland Cement Company, and for the C.P.R. at Fort William.

An attempt was made recently by the Association of Electrical Contractors in Vancouver to have a tax imposed on all parties or firms engaging in the electrical contracting business. This was designed to prevent the practice of journeymen taking work on their own account. The scheme, however, did not pass the City Council, the contention being that while they could license shops they could not impose a tax on individual workers.

The Dominion Government have just taken tenders for the supply and erection of four transmission line towers on the Welland canal.

Messrs. R. T. Walsh & Son will light the streets of Ormstown, Que., with electricity, the price being $8.50 per 32 c.p. lamp for twenty lamps or more for every night in the year.

Competitive bids were recently invited for supplying the city of Vancouver, B.C., with electric light. The cost at present for 375 direct current lamps is $93·07 per lamp per year. For the alternating current system the British Columbia Electric Railway Comyany put in a tender of $50 per lamp per annum on a ten year contract, and for direct current $60 for five years and $55 for ten years. The Stave Lake Power Co. tendered at $61 per lamp for five years and $60 for ten years. Bids were also put in for the supply of current alone. The British Columbia Electric Railway Company's tender was 1.4 cent per kilowatt hour for five years and one cent per kilowatt hour for ten years. The Stave Lake Power Company's bid was $22.50 per kilowatt for five years and $22 for ten years.

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SPARKS.

Mr. G. H. Archibald, C. E., of Winnipeg, has submitted to the Council of Neepawa, Man., his report on the utilization of the White Mud river for the extension of the municipal power plant.

The Canada Furniture Manufacturers will light the village of Wiarton, Ont., for another year, their offer to the Council being $1,087.

The Town Council of Moose Jaw, N.W.T., last week awarded contracts for an extension of the electric light plant. The engine, boiler and accessories will be supplied by the Robb Engineering Company, Amherst, N. S., and the electrical apparatus by Allis-Chalmers Bullock, Limited, Montreal, through their western representative, Mr. L. J. Belnap.

Port Hope, Ont., is considering the advisability of installing a municipal electric plant for street lighting purposes. The existing lighting contract between Dr. Corbett and the town will expire in about four months.

The British Columbia Electric Railway Company propose to establish an electric tramway, light and power system for North Vancouver, which will mean an expenditure of probably $200,000. The company will increase the capacity of their generating station on the North Arm of the Inlet by installing another 3,000 h. p. unit. The step-down sub-station which will be required will likely be situated midway between North Vancouver and Moodyville, in which case electrical power will be available for the latter municipality.

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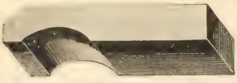
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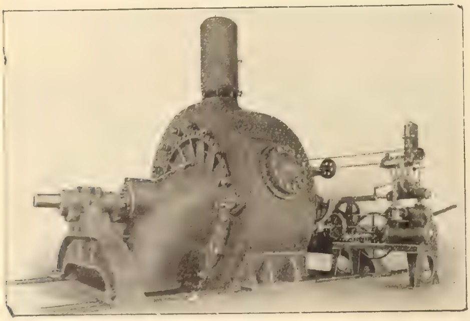

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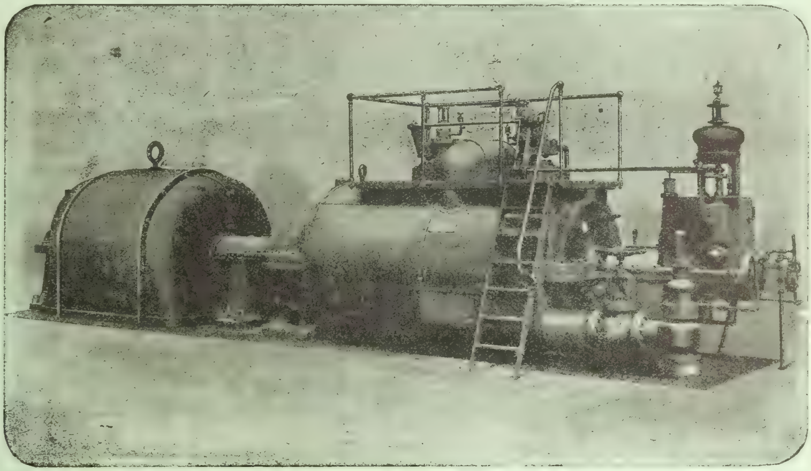

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High efficiency. Designed for any required speed or voltage.
We contract for complete installations.
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AND ENGINEERING JOURNAL

FIFTEENTH YEAR.
No. 10.

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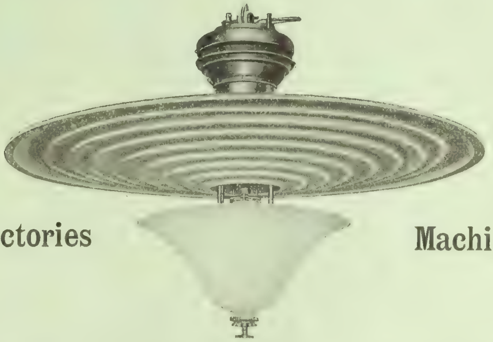

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For Advertising of Building Supplies it is ideal.

Send for sample copy and rates.

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A Weekly Journal of advance information and public works.
The recognized medium for advertisements for Tenders.
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TENDERS WANTED TENDERS WANTED

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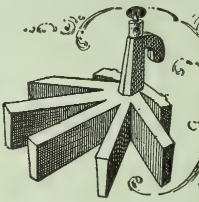

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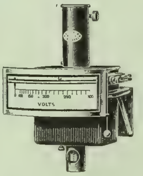

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Testing Sets for Insulation / Conductivity / Rail Bond and all kinds of Testing Apparatus.

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The Most Symmetrical and Substantial Line of
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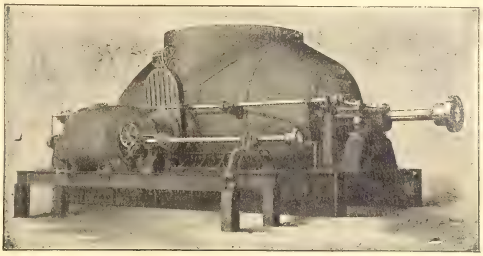
4,000 H. P., 80 ft. head, arranged to drive generator and a single turbine to drive exciter. Seven settings built for the Hudson River Water Power Company for their Spier Falls plant and 14 pairs 51 inch for their plant at Mechanicsville, N. Y.



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Write for catalogue if contemplating purchase of Turbines

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OF EVERY DESCRIPTION FOR

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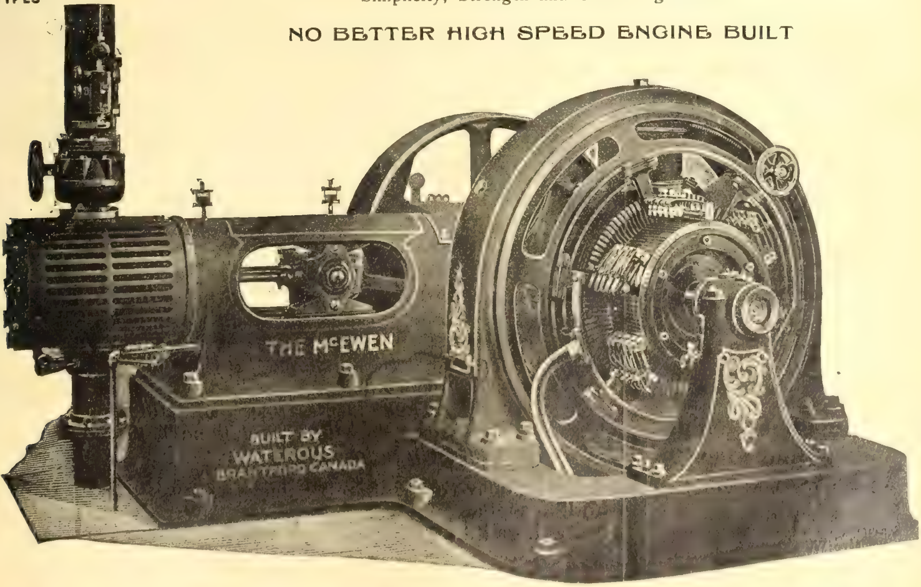
BUILT IN BOTH SIMPLE AND COMPOUND TYPES

THE McEWEN HIGH SPEED AUTOMATIC

Requires no introduction to the engineering public—Designed for Simplicity, Strength and Close Regulation.

NO BETTER HIGH SPEED ENGINE BUILT



WATEROUS, BRANTFORD, CANADA

PUBLICATIONS.

The National Electric Company, Milwaukee, Wis., describe in recent bulletins their direct current belt driven generators and Christensen's air brake equipments.

Printed literature reached us last month from the Canadian Westinghouse Company, Hamilton, Ont., referring to Westinghouse regulating and reversing controllors.

The Wellman-Seaver-Morgan Company, of Cleveland, Ohio, have issued a catalogue devoted to charging and manipulating apparatus for open-hearth and re-heating furnaces.

Accompanying the monthly "Pretty Girl Calendar" from the Pittsburg Transformer Company, is a small catalogue giving a brief history of the company and showing some of their latest types of transformers.

The Hill Electric Switch Company, in Bulletin No. 105, show illustrations of their Style "A" and Types "B" and "D" switches, also quick break switch blades, reinforced switch blades, and porcelain base "Beaver" baby knife switches.

The Westinghouse Companies Publishing Department, Pittsburg, Pa., have recently issued circular No. 1120, devoted to the Westinghouse No. 113 railway motor, and circular No. 1123 relating to Westinghouse prepayment wattmeters.

We have received from John Forman, Montreal, several catalogues and booklets referring to electric specialties which he is placing on the Canadian market. One of the most interesting is entitled "Modern Heating—Electricity," in which are shown the large lines of electric heating appliances manufactured by the American Electrical Heater Company, Detroit, Mich. Another catalogue contains the directions for testing and recalibrating the well known type "B" Guttmann wattmeters for alternating current.

A special publication has been issued by the Westinghouse Company, Pittsburg, entitled "Westinghouse Railway Apparatus", it being intended for distribution at the convention of the American Street Railway Association at Philadelphia. The book illustrates and describes the lines of alternating and direct current railway motors manufactured by the Westinghouse Electric & Manufacturing Company, as well as their generators for railway work and systems of control for electric railways.

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Is a Companion, Friend and Servant Combined.
Invaluable for convenience in the household.
LONG DISTANCE TELEPHONE SERVICE
has no equal for the facility it affords in business life.
Full particulars as to rates and service at the nearest office of the
BELL TELEPHONE COMPANY OF CANADA

FOR SALE
1 Westinghouse Alternator, single-phase, 120 K W., 2080 volt, 125 cycle, with blue Vermont panel, instruments, etc.
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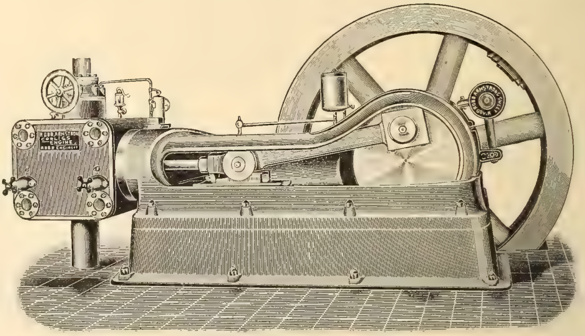
1 Wagner Single Phase Motor, 5 h.p., 104 volt, 125 cycle (new).
1 Wagner Single Phase Motor, 7½ h p. (2nd hand).
1 G.E. Sewing Machine Motor.
4 Emerson Desk and Bracket Fans.
Most of above apparatus has been in use but one year, and will be sold cheap.
WOODSTOCK ELECTRIC LIGHT SYSTEM,
Woodstock Ont.

A FINE STEAM PLANT



"I will say without qualification that it is as fine a boiler and engine plant as I have ever had the pleasure of seeing for its size. The engine was working without heating and absolutely without any noise. I wish to congratulate you on your success in building this class of engine and hope that we may have pleasure in dealing with you again"
The above refers to a 350 horse power Robb-Armstrong Corliss engine and two 175 horse power Robb-Mumford boilers installed by us.
ROBB ENGINEERING CO., Ltd.
AMHERST, N.S.
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THE GREATEST
responsibility resting upon our manufacturers and power users in Canada is that in connection with their Steam Plants. The Boiler Room is the place where precaution is taken.
The largest Steam Users regard the assistance of a responsible Company a necessity in order to provide protection and to insure a safe and economical maintenance of their Steam Plants.
The Canadian Casualty & Boiler Insurance Co.
22 Adelaide Street E., TORONTO
are specialists in Boiler Inspection, Consulting Engineers. We can save you money. Write us.
TELEPHONE MAIN 4091
A. G. C. DINNICK, Managing Director

SPARKS.

The capital stock of the Mexican Light & Power Company has been increased from $12,000,000 to $16,000,000.

The ratepayers of Woodstock, Ont., last month carried a by-law to raise $50,000 for improvements to the waterworks and electric light plants.

McLachlin Bros. are negotiating for a contract to operate the waterworks machinery at Arnprior, Ont., by electric power. They have in view the erection of a large dam on the Madawaska river.

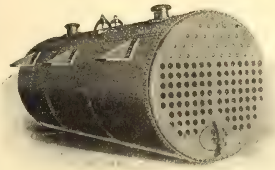
An Ontario charter has been granted to the Boiler Flue Cleaner & Supply Company, Limited, of Toronto, capital $100,000. The provisional directors are Messrs. D. W. Livingstone and T. H. Wark, of Toronto, and C. E. Adams, of London, Ont.

The Kaministiquia Power Company, who are developing the Kakabeka falls near Port Arthur, Ont., have let contracts to the Canadian General Electric Company for the generators, exciters, switchboards, etc., the total cost being, it is understood, in the neighborhood of $200,000.

At a meeting of the Georgian Bay Power Company, held at Eugenia Falls recently, an estimate was submitted by a well-known hydraulic engineer to the effect that the minimum amount of power available would be about 2,400 h. p. The construction of the plant will be proceeded with at once.

Tenders were recently invited for supply of additional apparatus for the municipal electric light plant at Victoria, B.C. The Hinton Electric Company were successful tenderers, at $9075. They will furnish C. G. E. apparatus. The same firm will also supply the necessary wire, at $22 per 100 pounds.

The Pre-Payment Electric Meter Company, Limited, Peterboro, Ont., has been incorporated with a capital of $100,000, to manufacture meters, motors, transformers, electric fans, etc. The provisional directors are Messrs. A. A. Hollingshead, William Hamilton, Alfred Parker, J. H. Larmoth and J. H. McClennan.



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Medium or High Pressure, All Sizes

High Pressure Tubular Boilers from 80 to 250 H. P. a Specialty

Write for Bulletin 112

THE JENCKES MACHINE CO., Limited
54 Lansdowne Street, SHERBROOKE, QUE.

THE

JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

MONTREAL, P. Q.

Boilers

All Sizes and All Pressures, Prompt Delivery.

Pumps

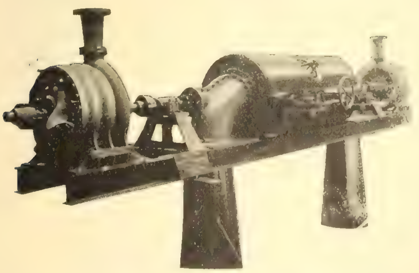
"Worthington" Pumps for Water Works and Mines.

Water Wheels

"Doble" Water Wheels for High Heads.

Mill Machinery

Etc.



Two Worthington 3-Stage Turbines and McCormick Water Wheels built for Port Arthur, Ont., Water Works. Combined Capacity, 1440 gallons per minute against 350 feet head.

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TRADE MARK

"Diamond H" Switches

Push Flush Switches
Flush Receptacle and Plug
Automatic Door Switches
Rotary Flush Switches
Steel Wall Appliances
Rotary Standard Switches

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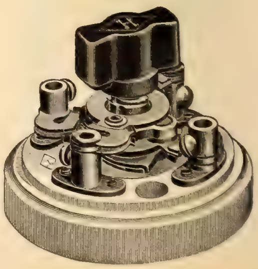
Toronto, CANADA



SPARKS.

The Pass Power & Lighting Company, Limited, of Frank, N. W. T., has been incorporated.

The St. John Street Railway Company are installing a new 600 k. w. generator to be used for lighting purposes.

The C. P. R. are installing an electric light plant at Brandon, Man., which is expected to be completed early this month.

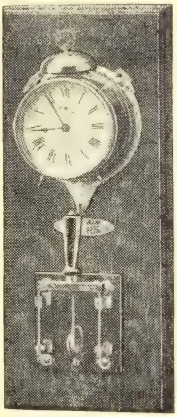
The British Columbia Electric Railway Company have purchased a lot in Victoria on which it is the intention to erect an office building.

Mr. W. J. O'Leary, of Montreal, has installed an electric light plant in the factory of the Restigouche Woodworking Company, Dalhousie, N. B.

The British Columbia Electric Railway Company have decided to install a steam plant in Victoria, to be kept as a reserve. The capacity will be 500 k.w.

A recount of the votes on the by-law recently submitted to the electors of Meaford, Ont., for purchasing the electric light plant of Moore & Sons, shows the by-law to have been defeated by two votes.

The Jones & Moore Electric Company, of Winnipeg, Man., have a large amount of work on hand, the following being some of their contracts: G. W. Murray, planing mill, installing 35 k.w. generator, 25 h.p. motor and 250 lights, all 220 volts; A. A. Gray & Company, supplying and installing 40 h.p. motor; Holy Trinity church, new motor and controlling devices for the organ; Douglas & Company, furriers, supplying and installing motor; International Harvester Company, complete wiring installation for their Winnipeg Agency; House Furnishing Company, complete wiring installation (800 amp.) including 200 six light fixtures, also wiring for one 25 and one 15 h. p. motors and supplying and installing switchless intercommunication telephones throughout their premises; Canadian Moline Plow Company, complete installation of wiring and fixtures for their new Winnipeg warehouse; Commonwealth Block, re-wiring old building and installing new wiring throughout new addition: Central Congregational Church, installing complete lighting system; Winnipeg General Hospital, wiring of old buiding and new installation in new wing; The Cadallac Apartments, complete wiring installation, fixtures and telephones.; The Boniveen Apartments, complete wiring installation and fixtures; The Pease Waldron Company, complete system of lighting for their Winnipeg agency; The Perchinie Apartments, complete wiring installation.



B. & W.
- Automatic Time Switch -

Don't waste your current. Let a B. & W. Automatic Time Switch control your window lights and signs. Always on time. Type A turns "off." Type B turns "on" and "off."

Simple--Reliable--Moderate Price
Send for Circular

--Manufactured by--
THE BERLIN ELECTRIC CO., BERLIN, ONT.

PACKARD TRANSFORMERS

The Best That Money Can Buy

Designed to Meet the Most Rigid Specifications
—BUILT TO STAND—
Capacities from 1 to 500 k.w.

The PACKARD ELECTRIC CO., Limited
ST. CATHARINES
MONTREAL WINNIPEG

SPARKS.

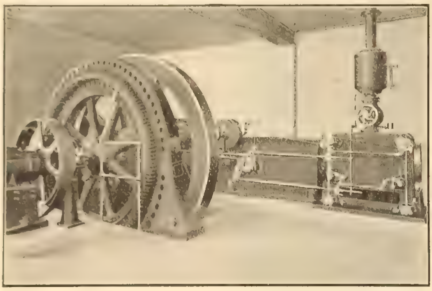
Stephens & Hawkins, electrical supplies, Victoria, B. C., have admitted Mr. C. E. Hayward as a partner.

The Magann Air Brake Company, of Detroit, are now engaged in equipping the cars of the Toronto Street Railway Company with air brakes.

Mr. C. H. Tracey, C. E., of Vancouver, has furnished an estimate of the cost of installing an electric light plant for the municipality of Ladysmith, B. C.

Two propositions for electric power franchises are before the Council of New Liskeard, Ont.; one is from Mr. S. Pindell, of Sault Ste. Marie, Mich., and the other from Mr. E. T. Orde, of New Liskeard, who has associated with him Messrs. Jennings, Woods and Wilson, of Toronto.

The Montreal Light, Heat & Power Company have employed the Ambursen Hydraulic Construction Company, of Boston, as expert contracting engineers, to reinforce their solid dam at Chambly, on the Richelieu river. The work involves the laying of several thousand yards of concrete under from 20 feet to 25 feet of water. The work will largely be performed by divers. It will be carried on night and day by the use of submarine electric lights.



HEAVY DUTY CORLISS ENGINES

Built either Simple or Compound for Speeds up to 150 Revolutions per minute. Particularly adapted for direct-driven electrical work.

THE GOLDIE & McCULLOCH CO., LIMITED

GALT, ONTARIO, CANADA

We Make Wheelock Engines, Corliss Engines, Ideal Engines, Gas and Gasoline Engines, Boilers, Steam and Power Pumps, Water Wheels, Oatmeal Mill Machinery, Flour Mill Machinery, Gyrators, Wood-Working Machinery, Shingle Machinery, Heading and Stave Machinery, Wood Rim Split Pulleys, Iron Pulleys, Shafting, Hangers, Gearing, Couplings, Friction Clutch Couplings, Clutch Pulleys, Safes, Vaults and Vault Doors.

The ALPHA PORTABLE LAMP GUARD

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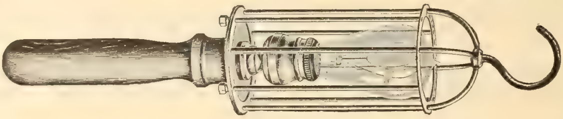

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PERSONAL.

The German Engineers' Association has conferred the Grashof medal on Messrs. Parsons and De Laval, the pioneerrs in turbine propulsion.

Captain Harbottle has been appointed by the Dominion Government meter inspector for the province of Alberta, with headquarters at Edmonton.

Mr. Frank H. Halford, who for many years has been chief engineer of the Pere Marquette Railroad, has accepted an appointment as chief engineer of the Canadian White Company.

Messrs. J. G. White & Company, New York, announce that they have secured for assistant to the secretary Mr. William R. Strickland, who has resigned from the New York Central Railroad.

Mr. William O'Donnell, of the firm of Porter & O'Donnell, who have charge of the electric light plant at Fredericton, N.B., was married on September 13th at St. Dunstan's church to Miss Kelley, of Victoria Mills.

The many eastern friends of Mr. Frederick Hoffmeister, who recently went to Vancouver as general electrical superintendent of the British Columbia Electric Railway Company, will regret to learn that he has been compelled by ill health to tender his resignation.

Mr. J. S. MacDonald, who for some years has been superintendent of the Government telegraph lines in the Northwest, with headquarters at Qu'Appelle, has been appointed general inspector of the Government telegraph service in Saskatchewan, Alberta and Southern British Columbia.

Mr. C. B. Smith, engineer for the Ontario Hydro-Electric Power Company and the Temiskaming Railway Commission, has gone to Europe to gather information concerning electric railways. He will likely visit Germany, France Italy, Switzerland and England.

The death occurred on September 30th last of Mr. William B. Rankine, vice-president of the Niagara Falls Power Company and the Canadian Niagara Power Company. He took an early and active interest in the development of electric power at Niagara Falls and did much for the upbuilding of the city. He was fifty-seven years of age.

Mr. C. W. Bongard, head of the well known electrical supply firm of C. W. Bongard & Company, Toronto, has become a benedict. The event occurred at Guelph, Ont., on October 2nd, the bride being Miss Helen Monica Kloepfer, only daughter of Mr. C. Kloepfer, ex-M. P. for South Wellington. The officiating clergymen were Rev. Father Wm. Kloeper, uncle of the bride, assisted by Rev. Father Herbert Aims. Many handsome presents were received as an evidence of the high esteem in which the contracting parties were held. Upon returning from a trip to the Eastern States they will reside at 113 Tyndall avenue, Toronto, where they have a very pretty home.

The Canadian Turbine & Propulsion Company has been registered to do business in Montreal. Mr. Marcus Auerbach is president.

The Laurie Engine Company, Montreal, are installing a direct connected slow speed Corliss engine in the power house of the St. John Railway Company, St. John, N. B. They have just shipped one of their standard Corliss engines to Seven Islands, in the Gulf of St. Lawrence, to be installed in a pulp mill now under construction, and are building a cross compound Corliss engine and Simplex power pump for the Rolland Paper Company, St. Jerome, Que.

The Government of Switzerland has planned to apply electricity to all the Government railway lines and to operate these lines from water-power plants, utilizing the mountain streams as a source of energy. Two experts sent by the Swiss Government to the United States to study electric railway methods arrived at New York last month. These are W. Wyssling, of Zurich, secretary-general of the commission for the study of the electrification of railways and commissioner of the Government for electric railway studies, and Charles Wirth, of Berne, Government engineer.

Thawing

Frozen Pipes.

Not as premature as you may think, as it won't be long now before Jack Frost is doing business at the old stand. Pipe Thawing Book is now in press—better write soon for a copy and ask for quotation on

The 1906 Thawer

Pittsburgh Transformer Company
Pitsburgh, Pa.

SPARKS.

A lighting plant for the village of Russell, Man., is being agitated.

The dissolution is announced of The Shelby Company, dealers in electrical apparatus and supplies, Montreal.

The Southern Okanagan Power Company, Limited, has been incorporated by the British Columbia Government.

Joseph Brosseau, a lineman employed by the Ottawa Electric Company, was electrocuted in Hull while working at a wire.

The C. P. R. are installing a Parsons steam turbine and another 500 k.w. Westinghouse generator in their power house at Fort William, Ont.

The City of Kingston, Ont., has been granted permission to issue debentures to the amount of $20,000 for improvements to the electric light plant.

The Canadian Westinghouse Company, Hamilton, will supply two 5,000,000 gallon pumping engines for the city of Toronto, their tender being $68,411.

A by-law to authorize the Council of Exeter, Ont., to purchase the existing electric light plant at a price not to exceed $18,000, was defeated by eight votes on September 24th.

The Ontario Transmission Company, Limited, incorporated under a Dominion law, has been granted a license to carry on business in Ontario. Mr. F. W. Hill, of Niagara Falls, Ont., is their attorney.

The Town Council of North Toronto, Ont., have appointed a committee to secure information as to the cost of installing an incandescent electric light plant. The intention is to submit a by-law to the ratepayers in January.

The Oshawa Heat, Light & Power Company, Limited, Oshawa, Ont., has been incorporated, with a capital of $100,000. The provisional directors are Messrs. Peter Ryan and R. J. Goudy, of Toronto, and L. E. Dancey, of Goderich, Ont.

The West Kootenay Power & Light Company have given a contract to the Rossland Engineering Works for 111 tons of pins to be used in the insulation of the new high tension pole lines. Each pin will be 24 inches long and 1¼ inches in diameter.

The Town Council of Napanee, Ont., have accepted the tender of Allis-Chalmers-Bullock, Limited, for the supply of two generators, at a cost of $5,480, and that of the R. E. T. Pringle Company for 25 arc lamps, transformers and regulators, at $1,475.

The ratepayers of Chatham, Ont., are not satisfied with the present lighting service, and the Council have appointed a committee to report on the necessary improvements to the plant. It is probable that a new dynamo and new lamps may be installed.

The Hamilton Cataract Power, Light & Traction Company are laying 90-pound rails on the extension from Burlington to Oakville and are also grading it for a double track. In addition, they will double track the radial line from Burlington to Hamilton next spring.

T. Costello was killed while working for the West Kootenay Power & Light Company near Murphy Creek. He was engaged with others in blasting holes for poles, when the force of the ascending rock broke one of the high tension wires. Deceased walked against the live wire and was instantly electrocuted.

In trying to account for the origin of the fire which recently destroyed a flour mill in Toronto the daily papers as usual surmised that electricity was at the bottom of the disaster. As a matter of fact the owners of the mill lighted the building by their own dynamo, which ceased operation at midnight, while the fire occurred three or four hours later.

A Dominion charter has been granted to The Mouterde's Electric Accumulator Company, Limited, with a capital stock of $250,000 and headquarters in Montreal. The company intend to acquire the patent rights belonging to Francis Mouterde. The promoters of the company are Messrs. Francis Mouterde, electrical engineer, E. Lepage, merchant, Alphonse Moisan, traveller, all of Montreal; J. G. Ryan, manufacturer, of New York, and J. S. Visger, mining broker, Denver, Col.

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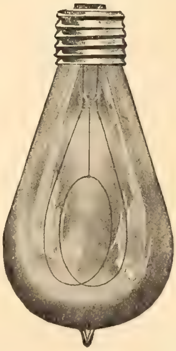

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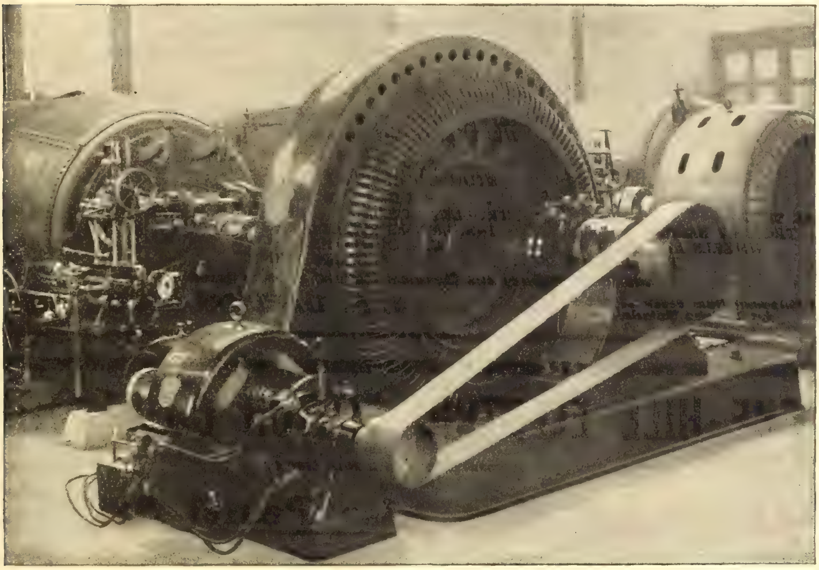

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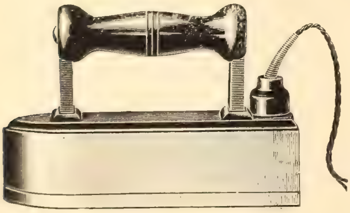

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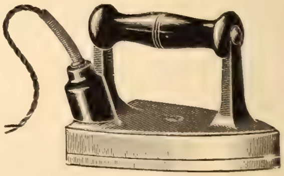

JOHN FORMAN 708-10 Craig St., Montreal, Que.

CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

VOL. XV. OCTOBER, 1905 No. 10.

Transmission Plant of the Mexican Light and Power Company*

By Francis O. Blackwell.

The plant of the Mexican Light & Power Company at Necaxa, Mexico, will be one of the largest power plants in the world and, in addition, will deliver power over a greater distance (171 miles) than has yet been undertaken by any other installation. The Tenango and Necaxa rivers drain a portion of the central plateau on which the City of Mexico is situated, and at a point about 100 miles northeast of the City, pass through the mountains at an elevation of 4,300 feet above sea level. A few miles below the town of Necaxa the Tenango river flows into the Necaxa river and eventually discharges into the Gulf of Mexico about sixty miles farther east.

There exists on both rivers a remarkable series of waterfalls with a total drop of about 3,000 feet in 3 miles. The rivers have a combined drainage area of 227 square miles upon which the rainfall varies from 85 to 135 inches per year, most of it being concentrated in the rainy season from May to December. The combined flow of the streams is, as might be expected, extremely variable, the minimum recorded flow being one cubic metre a second and the maximum 90 cubic metres. The average flow during the year of lowest recorded rainfalls was about 7 cubic metres per second.

The plan of development decided upon was to turn the Tenango river into the Necaxa by means of a diverting dam, 16½ feet high and 280 feet long, and a tunnel 11 x 7 feet in cross section and 3,000 feet long. A favorable location for a large storage reservoir exists at Necaxa, making it possible to equalize the entire flow of the streams during a dry year. A short distance below the site for the reservoir there are two falls in the Necaxa river, one 300 and the other 730 feet in height, which, together with the rapids above and between them, give a total fall of 1,300 feet in a mile. The initial plant will utilize this head, but there is a further fall immediately below of 1,300 feet which will be developed as soon as the first plant is completed. The two plants will eventually be capable of furnishing 80,000 electric horse-power.

The ground at the site of the dam is an unreliable volcanic rock, and, as no rigid bottom exists upon which to build masonry, an earth dam has been decided upon. This dam will be 177 feet high and 600 feet long at the crest, with a width at the base of 950 feet, and at the top of 54 feet. The slopes will be 3 in 1 on the up stream and 2 in 1 on the down stream faces. About 2,000,000 cubic yards of material will be required in its construction, and will be obtained from the neighboring hills and sluiced into place by the methods that have been so successfully used in many hydraulic fill dams in the western part of the United States under similar conditions.

The hydraulic system originated in the placer mines in California and is the most rapid and economical method of excavating and transporting large quantities of earth and rock wherever a sufficient volume and head of water are available, as at Necaxa. The method employed is to first loosen the earth by blasts and then wash the material into flumes which carry it to the site of the dam. A low embankment is first made at the upper and lower sides of the fill and drainage culverts are provided to the centre. The flumes discharge their contents near these embankments, the coarse stone and gravel settling there, while the finer materials are deposited near the centre, forming an impervious core wall. As an additional protection, the inner and outer slopes of the dam are protected by a layer of broken stone from 8 to 60 feet thick. The spillway is cut out of the hills to the north and discharges the overflow well down stream where it cannot endanger the work.

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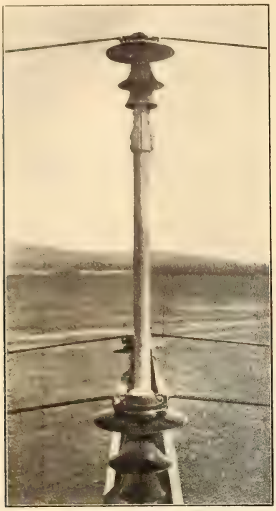
* Extracted, by permission, from "Electric Power Developments in Mexico" in Cassier's Magazine.


Mexican Light and Power Company—View of Insulators made by R. Thomas & Sons Company, East Liverpool, Ohio.

The reservoir formed by this dam, when full, will cover an area of three square miles and have a storage capacity of 1,580,000,000 cubic feet. The outlet from the reservoir will be through a tunnel 1550 feet long, driven in the rock to the south of the dam. Water is admitted through screens to two vertical pipes embedded in concrete, each pipe having gates at four different levels, so that the gates will not have to be operated under pressure.

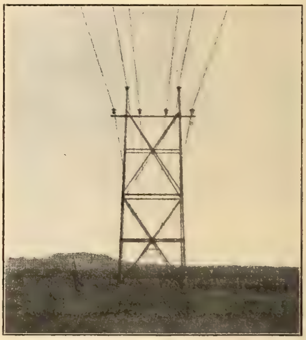
The vertical pipes are joined to horizontal penstocks, 8 feet in diameter and ⅜ inch thick, which pass through the tunnel, the latter being subsequently filled with masonry. The penstocks, after they leave the tunnel, are reduced to a diameter of 7 feet and are carried down stream a distance of 2800 feet, 900 feet of which are through tunnels. At this point, under a head of 180 feet, the penstocks are joined to a receiver, 22 feet long and 7 feet in diameter, from which six smaller pipes conduct the water to the power house. All pipes are connected to the receiver through gate valves, and, in addition, a valve in the center of the receiver permits the two halves of the system to be separated from each other, so that either half can be shut down without interfering with the other.

The pipes from the receiver are carried down to the power house, a distance of 2300 feet, 1900 feet of which are through two parallel tunnels constructed at an angle of 41 degrees from the horizontal. There are three pipes in each tunnel supported on concrete with anchorages and expansion joints. These pipes are seamless steel tubes with flanges, each piece being forged complete from one piece of sheet steel. Before the flanges are hammered out, two cast steel clamping rings are slipped on each 30 foot section of pipe. The outside diameter of the tubes is 30⅝ inches throughout the entire length of the line. The internal diameter of the tubes is less at the lower end than at the upper on account of the pipe's greater thickness, which varies from 0.4 to 0.95 of an inch, the minimum diameter being 29 inches.

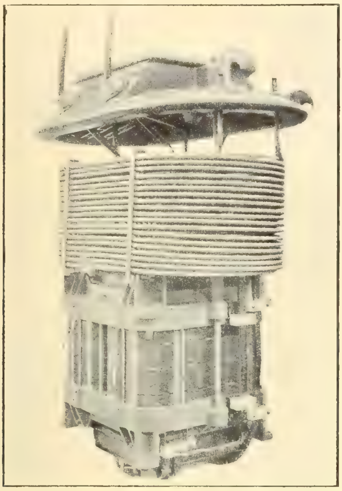
The static head at the lower end of the 30 inch pipe, with the reservoir full, is 1430 feet, which is reduced to 1300 feet when the reservoir is empty and the friction loss is allowed for. A vertical relief pipe, 240 feet high and 20 inches in diameter, is connected to the upper end of each penstock. Each section of tube before being shipped from the works of the manufacturer in Germany, was subjected to a hydrostatic test of twice the maximum pressure to which it will be subjected in service. This pipe is stronger and more reliable than one built up of plates and flanges riveted together, such as is commonly used, and the smooth interior will materially reduce the loss of head due to friction.

The power house is located in the Necaxa canyon a short distance below the 750 foot waterfall. It will have a rated output of 30,000 k. w. or 40,000 h. p., and a maximum capacity of 50,000 h.p. There will be six main water wheel units, each capable of delivering 8200 h.p. They are of the impulse type built by Escher, Wyss & Company, of Zurich, Switzerland, and are of 100 inches pitch diameter, running at 300 revolutions per minute. Each has two 4½ inch square regulating nozzles fixed on opposite sides of the wheel, but joined together so that they are opened and closed simultaneously.

A by-pass valve is provided at the end of the pipe line which feeds each unit and is mechanically connected to the nozzles, so that when one opens the other closes, keeping the flow of water in the pipe constant. This is necessary to avoid rams which might prove disastrous with such a high head and long penstock.


Mexican Light and Power Company—One of the Line Towers.

A vertical shaft, 14 inches in diameter, carries both the field of the generator and the water wheel. The weight is supported by a thrust bearing, 30 inches in diameter, under which oil is forced at a pressure of 150 pounds per square inch by a pump driven by the main water wheel. This construction has many marked advantages over impulse water wheels heretofore built with a horizontal shaft and a single deflecting nozzle. The double nozzle reduces the size of both the jet and the bucket, and permits the use of a smaller diameter of water wheel and a higher speed of rotation without sacrifice of efficiency. The nozzle and by-pass are much more easily operated and possess the other good features of a deflecting nozzle. As the nozzles are set in opposition to each other there is no thrust on the steady bearings, and no weight is carried by the latter, so that they need be only a fraction of the size required for a horizontal shaft. The diameter and length of the shaft itself can also be much reduced. The oil thrust bearing is a very simple and reliable device which operates with a minimum of attention.


Mexican Light and Power Company—One of the 60,000 Volt Transformers, Built by General Electric Company, Schenectady, N. Y.

The amount of water supplied to each wheel and the maximum power can be adjusted at the governor so that water will not be wasted unnecessarily, and the by-pass is also arranged so that, if desired, it can be adjusted to close slowly after opening—a feature which may be desirable with fairly steady loads.

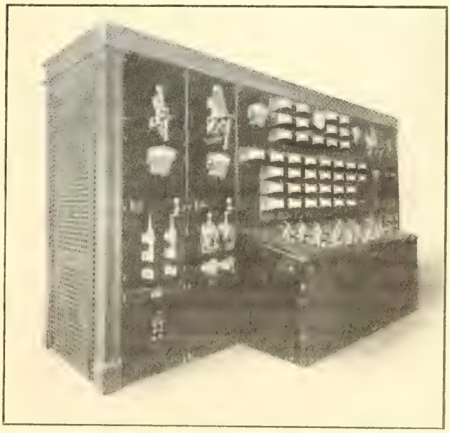
Each unit is equipped with a 28-inch diameter gate valve and a governor of the Escher-Wyss type, both operated by hydraulic power. The six 5,000-KW. alternators direct connected to the water wheels, running at 300 revolutions per minute, were furnished by the Siemens-Schuckert Werke, of Berlin. They are of the revolving field type and generate three-phase current at a periodicity of 50 cycles, and a potential of 4,000 volts. Two of the alternators are equipped with 60-KW., direct-connected, 125-volt exciters, but in ordinary operation exciting current will be obtained from two 250-KW., 125-volt generators driven by induction motors wound for 4,000 volts. Motor-generator sets are employed, because with small wheels the small nozzles are constantly stopped up by materials floating in the water.

The low-potential current from the generators is raised to high potential by five banks of oil transformers, each bank consisting of three 2,000-KW. units which can deliver power at 40,000, 50,000 or 60,000 volts to the transmission circuits. The transformers are each placed in a closed fireproof compartment, with steel bulkheads separating them from the generator room, on account of the large quantity of oil used to insulate them. The heat generated, due to the losses in the iron and copper, is carried away by copper cooling coils in the transformer cases, through which water is constantly circulated by motor-driven pumps.

The wiring consists either of cables in conduits or of bare wires in brick and concrete compartments, so that the damage from an arc is limited and cannot injure adjacent circuits. This is particularly important in laying out the 60,000-volt circuits, a substantial wall isolating every wire, switch or lightning arrester. The main switches are all of the oil type controlled electrically from a distance, and any switch will open instantaneously a short circuit of the entire power system. They are also equipped with disconnecting air switches so that they can be cut off from the system for repair and inspection. The high-tension wiring and the lightning arresters are all in a room by themselves behind the transformer pockets.

The oil switches are on the gallery above, with the controlling switchboard in the centre, where the operator can obtain an unobstructed view of the machinery in all parts of the building. The small controlling switches for the large oil switches are, with the miniature lamps which indicate their position, mounted on a benchboard with dummy bus-bars to form a wiring diagram so that the attendant can always see how the apparatus is connected and thus avoid mistakes.

On vertical panels above the bench-board are the indicating instruments which show at any instant the speed, potential and power at which the plant is operating. These instruments are also so placed with relation to the dummy busses and operating switches that the operator cannot become confused. At the back of the board are the registering instruments which make a record of the pressure and output of the plant.


Mexican Light and Power Company Switchboard in Power House, Furnished by General Electric Company.

The switchboard forms a room, with the instruments and controlling devices on the outside, and the doors at the ends to give access to the inside. The transformers and switchboard for the power house and sub-stations were furnished by the General Electric Company, of Schenectady, N.Y.

The power house is a substantial steel and masonry building, with concrete and cement roofs, floors and partitions, in which no combustible material of any kind is employed. All the machinery is placed where it can be readily handled by a 50-ton travelling crane. At one end are storerooms for supply and repair parts, and a machine shop equipped with all tools necessary to maintain the apparatus. The building is 235 feet long, 88 feet wide and 60 feet high.

The Necaxa plant is located in one of the most inaccessible parts of the State of Puebla, and for its construction it was necessary to build 30 miles of railroad, besides many miles of roads and trails. The material and machinery for the power house had to be lowered down cliffs and steep inclines by cableways for a vertical distance of 1500 feet, and nearly all the apparatus had to be transported over 4000 miles from Europe and the United States. A temporary plant, consisting of two Pelton water wheels driving air compressors and a 500-volt continuous current generator for operating the hoisting, pumping and other construction machinery, and lighting the work at night, was installed beneath the first fall at Necaxa.

There are four electric power transmission circuits and two tower lines from the power house to the City of Mexico, and two circuits from the City of Mexico to El Oro. They are carried by steel towers, on each of which are two circuits of 168,000-circular mils copper cable, equivalent to No. 000 B. & S. wire, supported on 14-inch diameter porcelain insulators. The towers for the transmission line are built up of steel angles with all parts heavily galvanized and with 3-inch x 3¼-inch corner posts spaced 16 feet apart across the line and 12 feet along the line. They are 50 feet high over all, the feet being set 5 feet in the ground. The six cables are supported 40 and 46 feet above the ground, the conductors forming two equilateral triangles with 6-foot sides. The towers will stand a horizontal side strain of 1650 pounds at each insulator pin, or 10,000 pounds altogether. The standard distance between them is 500 feet, but spans up to 1200 feet are made by allowing additional sag and employing special structures.

The insulators are made in three parts cemented together on the ground in Mexico. Each part is tested before shipment by subjecting them while wet to a test potential of 60,000 volts. After being assembled they are tested with a potential of 120,000 volts. The insulator pins are 15 inches long and made of 2-inch steel pipe set in drop-forged sockets, which in turn are mounted on a 4-inch pipe cross-arm for the lower conductors, and a 3-inch pipe extension for the upper. They are set into the insulators with Portland cement.

The conductors are six-strand copper cables, ½-inch in diameter, with hemp centers, and have a strength of 60,000 pounds and an elastic limit of 40,000 pounds per square inch. The cable is shipped in lengths of 3,000 feet, and joints are made with an 18-inch twisted copper sleeve. The stress on the cables and supporting structures is figured by assuming a wind velocity of 100 miles an hour and allowing a stress in the materials of one-half the elastic limit. The cables are attached to the insulators by clamps, no tie wires being employed. Telephone circuits of No. 10 copper wire are erected on each of the tower lines and are placed 10 feet below the high-potential cables.

The distance from Necaxa to Mexico is 96 miles, and from Mexico to El Oro 75 miles. The total length will therefore be 171 miles, making it the longest commercial power transmission yet constructed. There will be 1602 miles of cable and 534 miles of circuit in the high-potential system. The loss in the transmission circuits between Necaxa and Mexico will be 8 per cent. at full load, with 100 per cent. power-factor at 60,000 volts, so that the entire power can be delivered over two of the four circuits, or one-half the transmission system, with only 16 per cent. loss, should the other half be disabled. The loss in transmission from Mexico to El Oro is but 5 per cent.

The circuit breakers at Necaxa, Mexico and El Oro are arranged to automatically cut out any transmission circuit which becomes damaged without any interruption in the service. The sub-station buildings in the cities of Mexico and El Oro follow in general the design adopted for the power house. In Mexico there are twelve 1,800 kw. oil transformers in separate fireproof compartments covered by a travelling crane. The switches and wiring are in separate cells and every precaution has been taken to isolate all parts from each other. In addition to the high-tension apparatus, an extensive low-potential feeder system for the city distribution is provided for in the switch-board. The step-down transformers are arranged to furnish current at either 1,500, 3,000 or 6,000 volts, as may be required.

The building is 203 feet long and 65 feet wide, and is located adjacent to the company's steam station, originally built by the Siemens-Halske Company. This steam plant now supplies the public lighting of the city and much private lighting and power. In it are installed six 1200-H. P., triple-expansion, condensing engines, running at 120 revolutions per minute, direct connected to 60 cycle, 1500-volt, three-phase alternators. Four 1000-H. P. Curtis steam turbines running at 1500 revolutions per minute are now being erected in advance of the completion of the water power installation to take care of the rapidly increasing business. Later, this station will be kept as a reserve, although it now seems probable that steam will be required even after the water-power plant is in operation, as practically all the power from the first Necexa development has already been sold.

At El Oro, a sub-station 115 feet long and 59 feet wide has been erected. This is similar to the one in Mexico, and the seven 1800-kw step-down transformers installed there are duplicates of those in the latter city.

The distribution to the gold mines of the El Oro and Tlalpujuhua districts will be 3000 and 6000 volts. The mines at Tlalpujuhua were first worked three hundred years ago by the Spaniards, who are credited by tradition with having taken enormous quantities of silver from them. That gold existed in the neighboring town of El Oro was known for a century, but it was not until comparatively recently that the cyanide process made it possible to recover the metal from the ores. The great success of the El Oro Mining & Railway, the Esperanza and the Dos Estrellas Companies, has brought the camp into prominence, and many other properties are now being actively developed. Enormous bodies of ore, the veins in places being 200 feet thick, have already been opened up over a wide extent of territory, and El Oro promises to rival, if it does not surpass, the Rand in South Africa, as the world's greatest producer of gold. The mines must, however, be worked on a large scale to be profitable, and the introduction of cheap power has greatly stimulated the activities of the whole region.

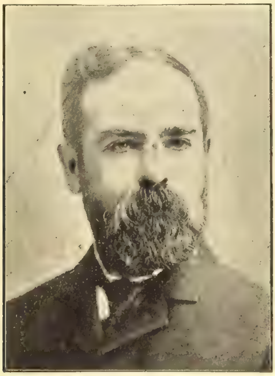
The Necaxa plant has been designed with ample reserve power so that the failure of no single piece of apparatus or combination of accidents ever will be likely to cripple the plant. The pipe lines will be in duplicate, reserve units of each kind of hydraulic and electric machinery will be installed, and the transmission lines will have double and quadruple circuits. The buildings, transmission towers and other structures are of permanent and reliable character.

Mexico is generally admitted to be the best lighted city on the American Continent, and it is expected that the same high standard of service will be maintained after water power has replaced steam.

TWO IMPORTANT APPOINTMENTS.

Mr. A. B. Smith, of Toronto, has been appointed manager of telegraphs of the Grand Trunk Pacific Railway, stepping up from the position of superintendent of construction and maintenance of the G.N.W. Telegraph Company. The responsible appointment has fallen to one of the best known telegraphers in Canada. He has been in the service from office boy to superintendent, is a skilled operator, and has few equals as an electrician and line builder. Mr. Smith is a Canadian of Scottish extraction, and has the energy and physical capacity to back up his mental talents in the great work he is about to undertake. He will enter his new duties about November 1.

Mr. Thomas Rodger, formerly manager of the Great North-Western Telegraph Company, Montreal, has been appointed inspector of telegraph and telephones of the Grand Trunk Railway system east of the St. Clair River, with headquarters at Montreal. Mr. Rodger is one of the best known telegraph men in Canada, and in making the appointment the Grand Trunk officials consider they have the right man for the position. Mr. Rodger was connected with the Montreal and Great North-Western Telegraph Companies for thirty years, having risen from "check" to the position of chief operator.



Mr. A. B. Smith.

Miniature roof protections for pole line insulators have become a necessity upon the high-potential transmission lines in California. The natural deposition of moisture upon them in fogs, or of dust in dry weather, is apt to cause escape of the current and eventual short-circuits resulting in burning and often destroying the pole. This is now provided against by sheltering all insulators by V-shaped boxes or sheds.

THE DOMINION EXHIBITION, NEW WESTMINSTER.

The recent Dominion Exhibition at New Westminster, B. C., was singularly successful. Notwithstanding the prevalence of rainy weather for the greater part of the time, the attendance was large and much interest was shown in the numerous exhibits. Mr. George A. Gall, the British Columbia representative of this journal, was permanently established on the grounds, his headquarters being shown in the accompanying engraving. Here he received hundreds of visitors from the West and some from the East. The publishers have unbounded faith in the future of Western Canada and intend in every possible way to promote the interests of western advertisers and subscribers. Our British Columbia office is located at Suite 3, 536 Hastings street, Vancouver, where friends of the paper will always be welcome.

Our Headquarters at the Dominion Exhibition, New Westminster, B. C., September 27 to October 7, 1905.

ELECTRIC LIGHTING IN VANCOUVER.

Tenders were recently invited by the City of Vancouver, B.C., for electric lighting. For an enclosed series alternating system the price of the British Columbia Electric Railway Company, $40 per annum per lamp, was the lowest. On the basis of 500 lamps it represented an expenditure in ten years of $200,000. The Stave Lake Power Company offered to supply power at $22 per kilowatt per annum, the city to install its own distributing plant. The City Engineer reported that the cost for a 500 lamp installation, including transformer station and all necessary equipment, would be about $85,000. He figures that the annual charges would be $18,734.45, or for ten years an expenditure of $187,334.50, this being a saving in favor of the city plant of $12,656.

Later the British Columbia Electric Railway Company amended their offer and agreed to supply arc lights for $38 per lamp per year on a ten year contract, and it is probable that a contract will be entered into on this basis.

HEAT AND EVAPORATION COMPUTER.

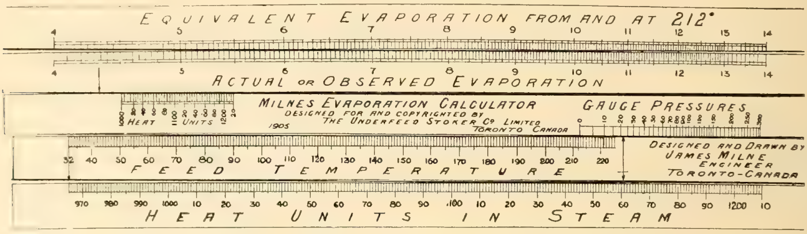
Mr. James Milne, chief engineer and manager of the Underfeed Stoker Company, Toronto, has designed an ingenious and useful heat and evaporation calculator, by the use of which the necessity of referring to steam tables in books is removed. The following explanation of the computer may be of interest:

This rule is marked so as to agree with Peabody's tables and the latent heat of steam at atmospheric pressure is taken at 966 units.

Its action is based on the formula $W \left(\frac{H-h}{966}\right)$

where W = Actual evaporation in lbs.
H = Total heat units in steam.
h = Temp. of feed deg. Fah.—32 = (t—32) Heat units in feed.

In working the rule the first thing to determine is H for a given boiler pressure. By placing the feed temperature on the lower slide so as to coincide with the boiler pressure and taking the reading on the lower scale of heat units as opposite 32 on the feed temperature slide we have H—(t—32) = (H—h). This gives the number of heat units supplied to every pound of water at a given feed temperature in order to convert same into steam at the observed boiler pressure.



The next process is to divide by 966, which is done in the designing of the rule, and all that remains is to multiply the actual evaporation by the factor of evaporation, which is readily done by taking the reading on the top scale agreeing with the actual evaporation on the upper slide.

The following rules and examples will illustrate the working of the rule:—

Rule 1.—To determine the heat units in steam at a given gauge pressure. Have the lower slide so that top or arrow points to the requisite steam pressure, the lower end of arrow points to heat units in the steam above 32 deg.

Example 1. What is the number of heat units in steam at 115 lbs. gauge pressure? Answer—1187.

Rule 2.—To determine the number of heat units applied to 1 lb. of water at a given steam pressure and feed temperature so at to convert same into steam. Set lower slide so that feed temperature agrees with steam pressure and opposite 32 at left hand of lower slide find number of heat units required.

Example 2.—Find number of heat units required to convert water at 127 deg. Fah. into steam at a gauge pressure of 125 lbs. Set 127 on lower slide so to agree with 125 lbs. gauge pressure and opposite 32 on slide find 1094 heat units.

Rule 3.—To find factor of evaporation. Set the lower slide so that the feed temperature agrees with the boiler pressure. Note the number on the lower scale of heat units corresponding to 32 deg. on lower slide. Set upper slide so that the arrow points to same number of heat units in middle division of rule. Above 10 on top slide find the factor of evaporation. Move decimal point to the left.

Example 3.—Feed temperature 127 deg. Fah. Boiler pressure 125 lbs. Find factor of evaporation correct to 3 decimal places. Set 127 on lower slide so as to agree with 125 lbs. gauge pressure and opposite 32 on slide find 1094 and above 10 find 35. Move decimal point one place to left, 1.135 factor of evaporation.

Rule 4.—To find equivalent evaporation from and at 212. Multiply actual evaporation by factor of evaporation, or move lower slide so that temperature corresponds to boiler pressure. Note number opposite 32 deg. on lower scale. Set upper scale so that arrow points to same number of heat units in middle division of rule. Above the observed or actual evaporation on top slide find the equivalent evaporation.

Take example 3 and assuming the actual evaporation is 8.5 lbs., what is the equivalent evaporation from and at 212 deg. per lb. coal.

Multiply 8.5 by 1.135. Above 8.25 on top slide find 9.65 on top scale.

LIGHTING IN TORONTO.

Tenders for street lighting in Toronto were opened on October 4th. The Toronto Electric Light Company were the only tenderers for electric lighting. The price paid at present for arc lights is 20½ cents per night, or $74.82½ per year, and the prices named in the new tender are:

Open arc, for five year contract, 19 cents per night, $69.55 per year; ten year contract, 17¾ cents per night, $64.79 per year; an increase in the number of lamps to more than 1,750 to reduce the price to $62.50.

Closed arc, five year contract, 17¾ cents per night, or $64.79 per year; ten year contract, 16½ cents per night, or $60.23 per year; an increase in the number of lamps to more than 1,750 to reduce the price to $57.49.

The city is paying at present for its gas lighting $32 per year per lamp, and the new tenders were as follows:

No. 1—Incandescent mantle, 60 candle power, $28.60; with reflector, 80 candle power, $28.60; iron posts, $33.

No. 2—Incandescent mantle, with or without reflector, 60 candle power, $28; 45 candle power, $26.

No. 3—Incandescent mantle, 70 candle power, $27; if gas is supplied at 80 cents a thousand, $25.50.

The present electric lighting contract expires at the end of this year and the gas contract on June 30, 1906.

INTERFERENCE OF BUILDINGS WITH ELECTRIC WIRES.

WINNIPEG, MAN., October 7th, 1905.

Editor CANADIAN ELECTRICAL NEWS:

DEAR SIR,—Noticing with interest the remarks in your September issue as to house moving interfering with wires, I thought it might be of interest to some who are suffering through this to give an idea of how we have met the difficulty here. I therefore enclose a copy of the by-law of the City of Winnipeg covering this point.

Before the passing of this law we (both the City Electrical Department and the various electrical companies) were much inconvenienced in many ways. We find, however, now that we have got some protection, that the question can be dealt with much better when brought under control.

Not only is the house moving without proper supervision a nuisance to those owning wires, but it is liable to prove a very dangerous element, as has been demonstrated on several occasions.

Yours truly,

F. A. CAMBRIDGE,

City Electrician.

BY-LAW NO. 3069.

A By-law of the City of Winnipeg for regulating the removal of buildings and structures on or across the streets and for regulating house movers.

The Municipal Council of the City of Winnipeg in Council assembled enact as follows:—

1. No building or structure shall be moved on or across any street of the City of Winnipeg except in compliance with and subject to the conditions of this By-law. When any person or persons desire to move a building or structure from one part of the City to another, involving going on or crossing a street, an application shall be made for a permit therefor to the City Engineer. Such application shall identify the building or structure to be moved and shall also indicate the route to be taken.

2. If the place to which it is intended to remove such building or structure is within the limits within which such class of buildings may be erected, a permit may be granted for removal. The City Engineer is to ascertain the character of the building, and to determine any question as to the Fire Limits may ask a report from the Building Inspector, who shall as soon as possible furnish same.

3. The Engineer shall ascertain whether any electric street railway, power, telegraph or telephone companies' wires or the wires of the City, may be affected by the removal of such buildings, and if it seems that they may be so affected, he shall direct notice to be given such interested Companies and the City Electrician of the application and of the time allowed for the removal of the building. It shall be the duty of the person obtaining such license before commencing to move any such building to notify the City Electrician and Company aforesaid whose wires may be interfered with by such removal of the time when he proposes to commence such removal so that such City or Company may have the necessary men on hand to protect, alter or remove their wires.

4. The City Engineer shall make an estimate of the amount necessary to recoup the City and the Companies whose wires may be affected for the cost of repairs to such wires, and for the wages of the men necessary to accompany said building during its removal to protect such wires, and in such estimate shall be incluced such sum as the City Engineer thinks necessary to repair injuries done to the City's pavement, and also to any wires or overhead constructions belonging to the City itself. In all cases the applicant shall pay not less than the sum of five dollars before obtaining their permit, and any sum additional thereto which the City Engineer shall determine is necessary for the purposes above mentioned, and such sums shall be held and paid by the city to re-imburse the said Company and the City itself for any damages to their or its wires caused by such removal and for any expense incurred in protecting such wires against damage during such removal, and any surplus after paying said amounts may be returned by the City to the person who paid the same.

5. No house-mover or other person shall drive any iron, wooden or other stake or spike or anchor or other instrument into or through the pavement of any street.

6. No house or other structure shall be moved on or across a street until a permit of the City Engineer has been issued, and such permit shall not be issued until the cash deposit ascertained as aforesaid has been made and the other pre-requisitions of this By-Law compiled with.

7. No house mover shall leave any building in the line of any wires, lamps or cables, but such moving shall be continuous until the building is perfectly clear of the wires, lamps or cables.

8. No building shall be left standing so as to prevent access to any fire alarm box, or to interfere with any street lamp, or so as to prevent the passage of any fire engine, hose reel or other fire apparatus.

9. No house mover shall break, cut, remove or interfere with any wire or wires, cable or appliances, the property of any Company, or the City, operating any system of telegraph, telephone, electric light, electric street railway or power. All necessary removing or cutting of wires necessitated by the moving of any building shall be done by the duly authorized workmen of the owners of such wires, and it shall be the duty of the City or any Company whose wires are or are likely to be affected by any such moving, being duly notified by the licensee as aforesaid, to have competent workmen in attendance during such moving who shall take all necessary precaution to prevent accidents or injury to the public, both in the use of the streets and highways and otherwise, and to prevent any damage to any building other than the building being removed.

THE NIAGARA DAM.

TORONTO, ONT., September 23rd, 1905.

Editor CANADIAN ELECTRICAL NEWS:

DEAR SIR,—Your September issue contains a brief description of a concrete dam that is to be built by the Queen Victoria Park Commissioners, to raise the level of the water in the waterworks intake, the intention being to build a "concrete tower with chains embedded in it, the tower to be upset into shallow water, where it will lie on the bottom, forming a submerged dam. When it falls into the river the sections will break apart, so that the dam will conform to the bed of the river, while the chains will hold them in line."

Now, will there be any permanency to such a structure, and is there any surety that it will act as intended? If it is to conform to the river bed it will necessarily need to be largest where the river is deepest, and if this is not done then the crest of the dam will be above the water at one point and below it at some other point, that is, there will be too much dam at one place and not enough at another.

Any additional material to correct this would not be chained to the original mass, and would be in danger of being carried away.

Then again, it is natural to suppose the stream to be the most rapid and destructive at the point of end of proposed dam, and this would be intensified by the dam itself. It is thus very likely that a furious current around the end of this dam would cause the outermost blocks to move and to tug at their chains, and with some assistance from ice the result would be disintegration.

This seems an irrational piece of engineering, and a little thought should involve a better plan. If two towers were built with cross struts and diagonals, all well reinforced with very mild steel rods, then the bracing would prevent the outer blocks from being carried away, and a qnadrangle would be formed into which other blocks could be deposited to make the structure secure, and a uniform crest line could be obtained.

Or again, an A frame could be let down with a derrick, the lower ends being securely held to the bank, and the outer end could be provided with a heavy rest block, other A frames could be let down to fit to the first one, then the interior space could be filled in with hollow concrete blocks fitting to each other or laid in rows on end between timbers, and the interior of these blocks could be filled in with concrete.

Many such ways could be devised that would be positive engineering that would be superior to the single tumbling tower referred to.

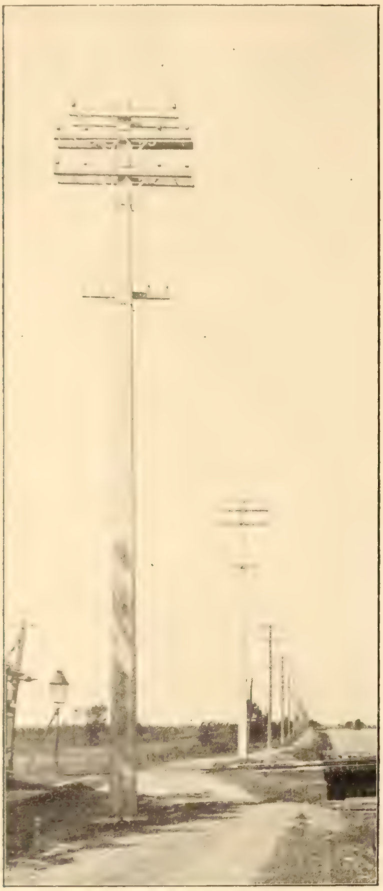
Yours truly,

JNO. S. FIELDING, C. E.

REINFORCED CONCRETE POLES.

The various electric transmission companies which have been organized within the past few years to transfer the energies of Canada's large and numerous water powers for hundreds of miles from the power producing plants have been, and are yet, in a state of uncertainty as to what style of support is best adapted for these long lines.

The cedar poles, which formerly could be procured at a small price, and of almost any dimensions, are becoming a thing of the past, being of an inferior quality, high in price and difficult to obtain. In addition to this the cedar poles require to be set very closely together, as their strength is not sufficient to carry the heavy wires used unless short spans are adopted. The adoption of short spans means large numbers of cross-arms and insulators, which would not be required on longer spans, and as the insulators are the weak points in long distance transmission, where continuity of service is absolutely necessary, it is very important that the number should be limited to the fewest possible.



Reinforced Concrete Poles on Welland Canal Transmission Line.

When the spans are increased in length, it becomes necessary to use stronger poles, and various styles of steel structures have been designed for the purpose and spans as long as 400 feet erected upon them. Steel poles have the disadvantage of being costly and require considerable expense in maintenance. Wide base towers which have been used instead of poles on account of cheapness have the further disadvantage of taking up considerable width of right of way, and being necessarily built of light material, will not have the same length of life.

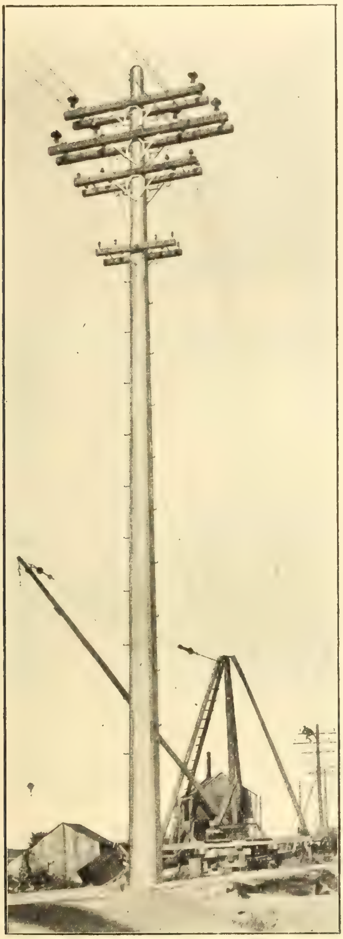
Mr. J. L. Weller, Mem. Can. Soc. C. E., Superintending Engineer of the Welland Canal, conceived the idea of a reinforced concrete pole to take the place of cedar and steel. The idea seemed so preposterous, however, that it was over two years after its first conception that the first pole was made. This was a failure on account of faulty reinforcement, and it was not until the third or fourth trial that a substantial pole was made, nearly two years ago. This pole when tested was so satisfactory that others were immediately built, and to-day there are nearly one hundred poles erected on the Welland Canal electrical transmission line. Some of these are shown in the accompanying illustrations. All the cedar poles for the line and two hundred steel poles 35 feet in height had already been contracted for by that time, consequently the concrete poles were used only in positions such as railway and road crossings where an extra high pole was required.

Reinforced Concrete Poles—Do not Require Guying or Bracing on Curves. Special Bases on these Poles.

The poles are manufactured on the ground with their butts immediately over the hole in which they are to be erected, as it has been found very expensive to transport them on account of their great weight ; a 35 foot pole for ordinary line work weighing about two and one half tons, and a 50 foot one about five tons.

Most of the poles so far made have been calculated to stand a horizontal pull at the top of 2,000 pounds, and tests that have been made show that the calculations have been correct, all standing the full load without any impairment, except one, which failed at 2,025 pounds, the cause being a flaw in the weld on one of the steel rods.

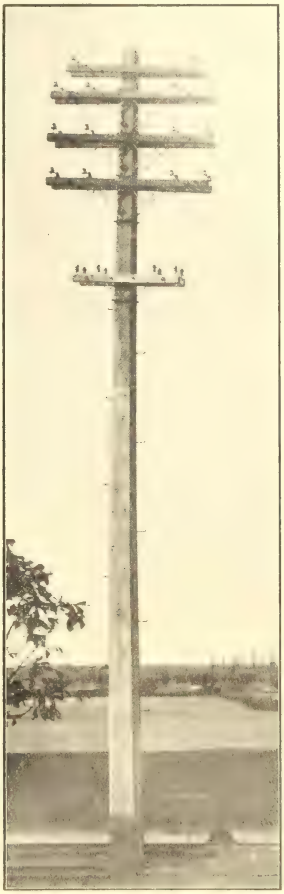
All poles have been made square, with the corners champered off, on account of ease in making and also on account of the saving in steel over any other section, each rod doing double duty, that is to say, if a pole is strained in one direction, rods A and B take up the tension, and if strained at right angles to the first direction rods B and C take up the strain, rod B thus acting twice. The steel reinforcement is figured on the fact that the stresses in a pole from a horizontal pull at the top gradually increase from the top downwards, the leverage increasing directly with the distance from the point of pull. The theoretical reinforcement would, therefore, be a rod tapering from nothing at the top to a certain diameter, depending on the strain, at the bottom. As these tapering rods are not rolled at present, the same effect is obtained as nearly as possible by welding different sized rods together, the diameter increasing by an eighth of an inch about every ten feet. Several trials were made to overcome the necessity of welding the rods, but hook joints or lapping the bars over each other at the junction gave very poor results, and all rods are now welded into one rod the full length of the pole.



Concrete Poles have a Pleasing Appearance.

The poles are moulded in wooden forms, in a horizontal position, the top side being left open and finished with a trowel. Foot steps are imbedded in the soft concrete as the pole is being made and bolts for cross-arms also, or holes are left so that a bolt may afterwards be put right through the pole. The concrete is composed of a 1:2:4 mixture, using the best Portland cement and clean sand and finely broken stone. Gravel has been used with success, in fact most of the poles so far have been built with gravel instead of broken stone.

Concrete poles are quite elastic, as is shown in one of the illustrations herewith, a pole 40 feet above the ground bending 12 inches under a strain of 2,000 pounds at the top. They do not require painting, being of a pleasing grey color, which, of course, will last indefinitely. They should last forever, as the weather is claimed to have no effect whatever on them. As there is some question about this latter assertion, attention may be drawn to a good granolithic sidewalk, which, if properly built, shows no signs whatever of age after 25 years, and a sidewalk during the spring, fall and winter is under much more serious stresses of weather than a pole could possibly be. Therefore, there seems to be no reason why the concrete pole may not be the pole of the future. They can be built of any desired height or strength.

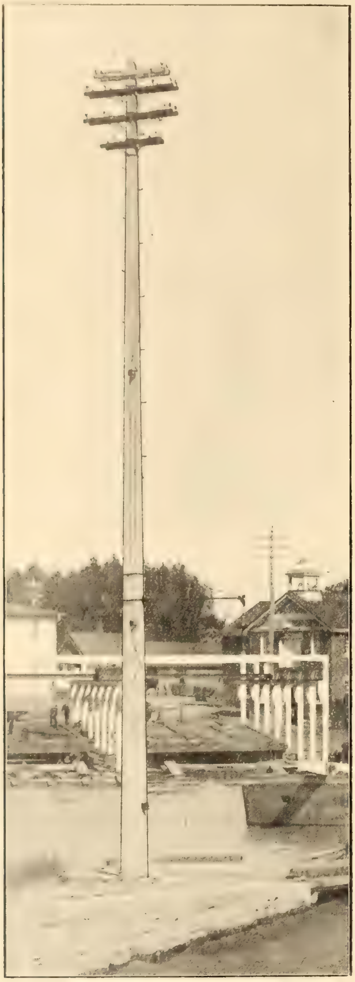


Notice the Bend in this Pole, which was not Designed to Stand the Heavy Strain of 18 Wires at a Sharp Angle and will have to be Guyed.

Arrangements are now being concluded for the building and erection of two poles 150 feet in height at St. Catharines to carry wires over the old Welland canal for the Lincoln Electric Light and Power Company.

The erection of the poles, especially such large ones as those mentioned above, which weigh about fifty tons each, is quite a serious matter, but they are being put up with very little trouble now, although at first several were broken through defective tackle.

The cost of these poles will depend on local conditions somewhat, and upon the specifications, as different users have different ideas as to the strength a pole should have for line work. As a general rule, however, the cost may be taken as about 25 per cent. less than that of a steel pole of similar strength.



70 Foot Concrete Pole Carrying Wires Over a "Slip" at Port Dalhousie.

To make these poles completely fire and time proof, concrete cross-arms would be a step forward, and these are now being experimented with.

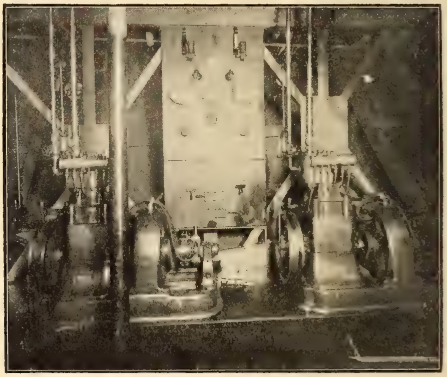
In cities where wooden trolley poles are not allowed, reinforced concrete poles should soon replace other forms, as they present a better appearance, are cheaper than steel, and will not rust off at the ground line as steel poles do.

Mr. Weller has patents granted or applied for in nearly every country in the world. He has disposed of his Canadian patent to the Concrete Pole Company, Limited, of St. Catharines, Ont.

ELECTRIC EQUIPMENT OF A FERRY BOAT.

Professor A. J. MacLean, naval architect, of New York, was commissioned by the City Council of St. John, N. B., to prepare plans for a steel ferry boat to ply between the cities of St. John and Carleton, N. B The contract for building same was awarded to Mr. James Fleming, of the Phœnix Foundry, while the installation of the electrical plant and equipment was carried out by Mr. Frank P. Vaughan, electrical engineer and contractor, St. John.

The length of the boat is 140 feet. The generating plant consists of two 4 k.w., 110 volt dynamos, 600 r.p.m., made by the Canadian General Electric Company and each direct connected to a single cylinder, 4¼ × 4 in., upright high speed engine, the steam connection being arranged for 80 pounds pressure. The commercial efficiency of the dynamos is guaranteed to be not less than 80.5 per cent., and the specifications provided that the voltage should not exceed 115 nor be less than 110 between full load and no load.



Electric Plant in Ferry Steamer "Ludlow," St. John, N. B.

The main switchboard is of slate 1¼ inches thick, mounted on an iron frame, with two positive busbars and one negative busbar permanently connected at the back and so arranged that the dynamos may be operated either separately or together on light circuits. The instruments consist of two double pole double switches, two automatic circuit breakers, two ammeters and one voltmeter of Western round pattern, two dynamo field rheostats, one six point voltmeter switch and double pole switches for hold circuits. There is also a distributing panel of slate 1¼ inches thick, enclosed in wooden frame.

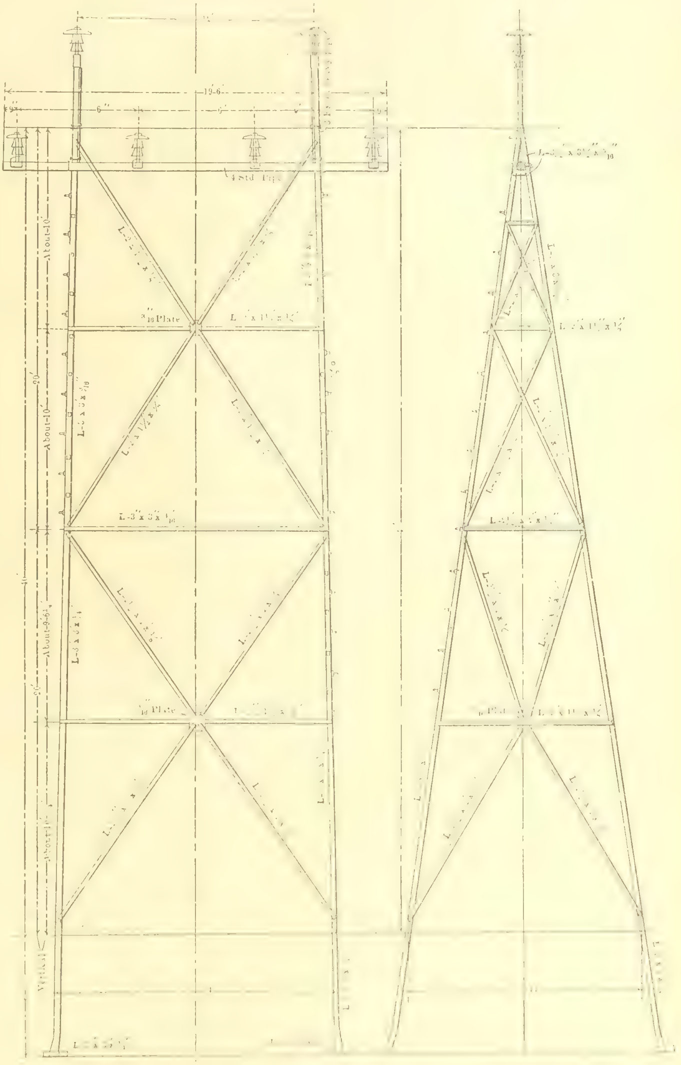
The two-wire system is used throughout the boat, but provision has been made to light the signal lamps and about 25 per cent. of the cabin lamps in case of break down of one of the generators by using a common return negative. In the hold and centre house the conductors are run in iron armored insulated conduits, while between the centre house and cabin the conductors are carried in mouldings, and in the cabins, pilot houses and all concealed places in circular loom.

While embodying no special features, the electrical equipment is very substantial and complete and in keeping with the general character of the boat.

THE USE OF STEEL TOWERS AND WOODEN POLES

Steel towers are rapidly coming into use for the support of electric transmission lines that deliver large units of energy at high voltages to long distances from water powers.

One case of this sort is the seventy-five-mile transmission of 40,000 horse-power at 60,000 volts from Niagara Falls to Toronto, for which a line with steel towers is now nearing completion. Another example may be seen in the seventy-five-mile line of steel towers which carries transmission circuits of 60,000 volts to Winnipeg. Guanajuato, Mexico, which is said to have produced more silver than any other city in the world, receives some 3,300 electric horse-power over a 60,000 volt transmission line 100 miles long on steel towers. Between Niagara Falls and Lockport the electric circuits now being erected are supported on steel towers. On a transmission line eighty miles long in northern New York, for which plans are now being made, steel towers are to support electric conductors that carry current at 60,000 volts.

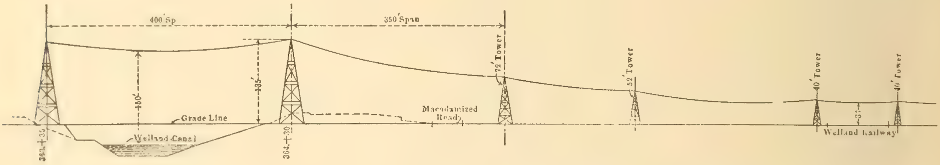


Steel Towers for the Niagara Falls and Toronto Transmission Line

For the elevations above ground at which it is common to support the conductors of transmission lines, that is from thirty to fifty feet, a steel tower will cost from five to twenty times as much as a wooden pole in various parts of the United States and Canada. It follows at once from this fact that there must be cogent reasons, apart from the matter of first cost, if the general substitution of steel towers for wooden poles on transmission lines is to be justified on economic grounds. During fifteen years the electric transmission of energy from distant water powers to important centres of population has grown from the most humble beginnings to the delivery of hundreds of thousands of horse-power in the service of millions of people, and the lines for this work are supported with very few exceptions on wooden poles. Among the transmissions of large powers over long distances at very high voltages that have been in successful operation during at least several years with wooden pole lines are the following: The 60,000-volt circuit that transmits some 13,000 horse-power from Electra station across the state of California to San Francisco, a distance of 147 miles, is supported by wooden poles. In the same state the transmission line is 142 miles long between Colgate power-house and Oakland, at 60,000 volts and with a capacity of about 15,000 horse-power, hangs on wooden poles, save at the span nearly a mile long over the straits of Carquinez. Wood is used to carry the two 55,000-volt circuits that run sixty-five miles from the 10,000 horse-power station at Canon Ferry on the Missouri river to Butte. Between Shawinigan Falls and Montreal, a distance of eighty-three miles, the conductors that deliver at least 6,000 horse-power are carried on wooden poles. Electrical supply in Buffalo to the amount of 30,000 horse-power depends entirely on circuits from Niagara Falls that operate at 22,000 volts and are supported on lines of wooden poles.

In the operation of these and many other high-voltage transmissions during various parts of the past decade some difficulties have been met with, but they have not been so serious as to prevent satisfactory service. Nevertheless, it is now being urged that certain impediments that are met in the operation of transmission systems would be much reduced by the substitution of steel towers for wooden poles, and it is even suggested that perhaps the first cost, and probably the last cost, of a transmission line would be less with steel than with wood for supports. The argument for steel in the matter of costs is that while a tower requires a larger investment than a pole, yet the smaller number of towers as compared with that of poles may reduce the entire outlay for the former to about that for the latter. More than this, it is said that the lower depreciation and maintenance charges on steel supports will make their final cost no greater than that of wooden poles.

In the present state of the market, steel towers can be had at from three to three and one-half cents per pound, and the cost of a steel tower or pole will vary nearly as its weight. During the first half of 1904 the quotations on tubular steel poles to the Southside Suburban Railway Company, of Chicago, were between the limits just stated. That company ordered some poles built up of steel sections about that time at a trifle less than three cents per pound. Each of these poles was thirty feet long and weighed 616 pounds, so that its cost was about eighteen dollars (xxi, A. I. E. E., 754). For a forty-five-foot steel pole to carry a pair of 11,000-volt, three-phase circuits along the New York Central electric road the estimated cost was eighty dollars in the year last named (xxi, A. I. E. E., 753). On the 100-mile line to Guanajuato, Mexico, above mentioned, the steel towers were built up of 3 in. x 3 in. x 3/16 in. angles for legs, and were stayed with smaller angle sections and rods. Each of these towers has four legs that come together near the top, is forty feet high, weighs about 1,500 pounds, and carries a single circuit composed of three No. 1 B. & S. guage hard-drawn copper cables. The weight of each of these cables is 1,340 pounds per mile, and the forty-foot towers are spaced 440 feet apart, or twelve per mile, over nearly the entire length of line. At three cents per pound, the lowest figure at which these towers could probably be secured for use in the United States, the approximate cost of each would be forty-five dollars. Between Niagara Falls and Lockport each of the steel towers that is to carry a single three-phase transmission circuit has three legs built up of tubing that tapers from two and one-half inches to smaller sizes, and is braced at frequent intervals The height of these towers is forty-nine feet, and the weight of each is 2,800 pounds. At three cents per pound the cost of each tower amounts to eighty-four dollars. For a long transmission line in northern New York bids were recently had on towers forty-five feet high to carry six wires, and the resulting prices were $100 to $125 each for a tower weighing about 3,000 pounds. On the seventy-five-mile line between Niagara Falls and Toronto the standard height of steel towers is forty feet from the ground level to the point where the two legs of each side join, and to this must be added a length of six feet that goes into the ground, and about three feet of pipe that run up from the junction of each pair of legs at the top, giving a total length of forty-nine feet exclusive of insulator pins. Except as to a cross-arm of standard four-inch steel pipe, and the two uprights of extra heavy three-inch pipe at the top, this tower is built up almost entirely of L sections that vary from 3″ × 3″ × ¼″ to 2″ × 1½″ × ⅜″. The weight of this tower is very close to 2,360 pounds, and its cost at three cents per pound would amount to about seventy dollars. Ou the line of these towers there are strung six hard-drawn copper cables with a cross-section of 190,000 circular mils each. Between these standard towers the maximum spacing is 400 feet, but this length of span is much reduced on curves and where the ground is uneven, so that about 1,400 towers are used on the seventy-five-mile line, which gives an average spacing of 283 feet.



Profile of Niagara Falls and Toronto Transmission Line at Welland Canal.

In January, 1902, four steel towers were purchased to support transmission circuits for two spans of 132 feet each over the Chambly canal, near Chambly Canton, Quebec. Each pair of these towers was required to support eleven No. 2/0 B. & S. gauge bare copper wires with the span of 132 feet between them. The vertical height of each of these four towers is 144 feet above the foundation, and they were designed for a maximum stress in any member of not more than one-fourth of its ultimate strength, with wires coated to a diameter of one inch with ice and under wind pressure. For these four steel towers erected on foundations supplied by the purchasers the price was $4,670, and the contract called for a weight in the four towers of not less than 121,000 pounds. On the basis of this weight the cost of the towers erected on foundations was 3.86 cents per pound.

With these examples of the cost of steel towers a fair idea may be got of the relative cost of wooden poles. For poles of cedar or other desirable wood thirty-five feet long and with eight-inch tops fitted with either one or two cross-arms an estimated cost of five dollars each is ample to cover delivery at railway points over a great part of the United States and Canada. This size of pole has been much used on the long, high-voltage transmission systems that involve large power units and use heavy conductors. Examples of lines where such poles are used may be seen between Niagara Falls and Buffalo, between Colgate power-house and Oakland, and between Canon Ferry and Butte. Of course some longer poles were used in special locations, like the crossing of steam railways, but it is also true that on the lines supported by steel towers such locations make exceptionally high towers necessary. The thirty-five foot poles will hold the electric lines about as high above the ground level as the forty-nine-foot towers on the Niagara Falls and Toronto transmission, because the former will be set so much closer together. On the line just named the regular minimum distance of electric cables above the ground level at the centres of spans is twenty-five feet. The standard towers on this line carry the lower electric cables forty feet above the ground at the insulators, and it was thought desirable to allow a sag of fifteen feet at the centres of the regular spans of 400 feet each. On these towers the couductors that form each three-phase circuit are six feet apart, and the lines drawn between the three cables form the sides of an equilateral triangle. With a pin fourteen and three-fourths inches long like that used on these steel towers, and one conductor at the top of a thirty-five-foot pole, where the other two are supported by a cross-arm five feet three inches below, giving six feet between cables, the lower cables are held by their insulators twenty-six feet above the ground, when the poles are set five feet deep. Between thirty-five-foot poles 100 feet is a very moderate span, and one that is exceeded in a number of instances. Thus on the 142-mile line from Colgate power-house to Oakland the thirty-five-foot poles are 132 feet apart, and one line of these poles carries three conductors of 133,000-circular-mil copper, while the other pole line has three aluminum cables of 168,000 circular mils. On the later transmission line from Niagara Falls to Buffalo, which has one three-phase circuit of 500,000-circular-mil cable, the regular distance between the thirty-five-foot poles is 140 feet.

A maximum sag of twenty-four inches between poles 100 feet apart under the conditions named above brings the lowest points of the electric cables twenty-four feet above the ground. The steel towers on the line to Guanajuato being only forty feet in length, and spaced 440 feet apart, it seems that the distance of conductors from the ground at the centres of spans is probably less than that just named. Particular attention is called to this point because it has been suggested that the use of steel towers would carry cables so high that wires and sticks could not be thrown onto them. It thus appears that thirty-five-foot wooden poles set 100 feet apart will allow as much distance between conductors, and still keep their lowest points as far above the ground, as will forty to forty-nine-foot towers placed 400 feet or more apart. The two lines that have their conductors further apart perhaps than any others in the world are the one from Canon Ferry to Butte, on thirty-five-foot wooden poles, and the one to Guanajuato, on steel towers. In each of these cases the cables are seventy-eight inches apare at the corners of an equilateral triangle. With steel towers 400 feet or wooden poles 100 feet apart, four of the latter must be used to one of the former. At $5 per pole this requires an investment of $20 in poles as compared with at least $45 for a tower like those on the Guanajuato line, $84 for a tower like those on the line from Niagara Falls to Lockport, or $60 for one of the towers on the Niagara and Toronto line. Each of the towers on the line to Toronto carries two three-phase circuits, and the least distance between cables is six feet. To reach the same result as the distance between conductors with the two circuits on poles, it would be desirable to have two pole lines, so that $40 would represent the investment in the poles to displace one tower for two circuits. The older pole line between Niagara Falls and Buffalo carries two three-phase circuits on two cross-arms, and the 350,000-circular mil copper cables of each circuit are at the angles of an equilateral triangle whose sides are each three feet long. In this case, however, the electric pressure is only 22,000 volts.

The costs above named for poles and towers include nothing for erection. Each tower has at least three legs and more commonly four, and owing to the heights of towers and to the long spans they support, it is the usual practice to give each leg a footing of cement concrete. It thus seems that the number of holes to be dug for a line of towers is nearly or quite as great as that for a line of poles, and considering the concrete footings the cost of erecting the towers is probably greater than that for the poles. With wooden poles about four times as many pins and insulators are required as with steel towers, or say twelve pins and insulators on poles instead of three on a tower. For circuits of 50,000 to 60,000 volts the approximate cost of each insulator with a steel pin may be taken at $1.50, so that the saving per tower reaches not more than $13.50 in this respect. In the labor of erecting circuits there may be a small advantage in favor of the towers, but the weight of the long spans probably offsets to a large extent any gain of time due to fewer points of support.

An approximate conclusion from the above facts seems to be that a line of steel towers will probably cost from 1.5 to twice as much as a line or lines of wooden poles to support the same number of conductors the same distance apart, even when the saving of pins and insulators is credited to the towers. This conclusion applies to construction over a large part of the United States and Canada. It is known that wooden poles of good quality retain enough strength to make them reliable as supports during ten or fifteen years, and it is doubtful whether steel towers will show enough longer life to more than offset their greater first cost. It may be noted here that any saving in the cost of insulators or other advantage that there may be in spans 400 feet or more long can be as readily secured with wooden as with steel supports. With these long spans the requirements are greater height and strength in the line supports, and these can readily be obtained in structures, each of which is formed of three or four poles with cross-braces. Such wooden structures have long been in use at certain points on transmission lines where special long spans were necessary, or where there were large angular changes of direction. In those special cases where structures 75 to 150 or more feet in height are necessary to carry a span across a waterway, as at the Chambly canal above mentioned, steel is generally more desirable than wood because poles of such lengths are not readily obtainable. Neither present proposals nor practice, however, contemplates the use of steel towers having a length of more than forty to fifty feet on regular spans.

Much the strongest argument in favor of steel towers for transmission lines is that these towers give a greater reliability of operation than do wooden poles. It is said that towers will act as lightning-rods and thus protect line conductors and station apparatus As to static and inductive influences from lightning it is evident that steel towers can give no protection. If each tower has an especial ground connection it will probably protect the line to some extent against direct lightning strokes, but there is no reason to think that this protection will be any greater than that given by well grounded guard wires, or even by a wire run from a ground plate to the top of each pole or wooden tower. If a direct lightning stroke passes from the line conductors to a wooden support it frequently breaks the insulator on that support, and the pole is often shattered or burned. Such a result does not necessarily interrupt the transmission service, however, as the nearby poles can easily carry the additional strain of the line until a new pole can be set. Quite a different result might be reached if lightning or some other cause broke an insulator on a steel tower, and thus allowed one of the electric cables to come into contract with the metal structure, as the conductor would then probably be burned in two. To repair a heavy cable thus severed where the spans were as much as 400 feet long would certainly require some time. Where a conductor in circuits operating at 20,000 to 35,000 volts has in many cases dropped onto a wooden cross-arm, it has often remained there without damage until discovered by the line inpector, but no such result could be expected with steel towers and cross-arms (xxi, A.I.E.E., 760.) Where steel towers are employed it would seem to be safer to use wooden cross-arms, for the reason just stated. This is, in fact, the practice on the steel towers before named, that support 25,000-volts circuits over the Chambly canal, and also on the steel towers that carry the 60,000-volt circuits from Colgate powerhouse over the mile-wide straits of Carquinez.

On the 40,000-volt transmission line between Gromo and Nembro, Italy, where timber is scarce and steel is cheap, both the poles and cross-arms are of wood. It is thought that the comparatively small number of insulators used where a line is supported at points about 400 feet apart should contribute to reliability in operation, but insulators now give less trouble than any other part of the line, and the leakage of energy over their surfaces is very small in amount, as was shown in the Teleuride tests. Whatever benefits are to be had from long spans are as available with wooden as with steel supports, and at less cost.

One advantage of steel towers over wooden poles or structures is that the former will not burn, and are probably not subject to destruction by lightning. Where a long line passes over a territory where there is much brush or timber the fact that steel towers will not burn may make their choice desirable. In tropical countries where insects rapidly destroy wooden poles the use of steel towers might be highly desirable even at much greater cost, and such a case was perhaps presented on the line to Guanajuato, Mexico.

Mechanical failures of wooden insulator pins have been far more common than those of poles, both as a direct result of the line strains, and because such pins are often charred and weakened by the leakage of energy from the conductors. For these reasons the general use of iron or steel pins for the insulators of long lines operating at high voltages seems desirable. Such pins are now used to support the insulators on a number of lines with wooden poles and cross-arms, among which may be mentioned the forty-mile, 30,000-volt transmission between Spier Falls and Albany, and the forty-five-mile 28,000-volt line from Bear river to Ogden, Utah. Iron or steel pins add very little to the cost of a line, and materially increase its reliability. One of the cheapest and best forms of steel pins is that swaged from a steel pipe, and having a straight shank and tapering stem with no shoulder. A pin of this sort for the 400-foot spans of 190,000-circular-mil copper cable on the line from Niagara Falls to Toronto measures three and one-quarter inches long in the shank, eleven and one-half inches in the taper, and has diameters of two and three-eighth inches at a larger and one and one-eigth inches at the smaller end.

On long transmission lines where the amount of power involved is very large, the additional reliability to be had with steel towers is probably great enough to justify their use. For the great majority of power transmissions, however, it seems probable that wooden poles or structures will long continue to be much the cheaper and more practical form of support.—Alton D. Adams, in Electrical Review.

WESTINGHOUSE SINGLE PHASE RAILWAY SYSTEM.

A contract awarded to the Westinghouse Electric & Mfg. Company by the New York, New Haven and Hartford Railway for twenty-five electric locomotives is another victory for the alternating current system and conclusive evidence of its success in the field of electrical transportation. Each of these locomotives will weigh approximately 78 tons and in local service with a 200-ton train will attain a speed of 45 miles an hour, while a speed of 60 to 70 miles an hour with a 250-ton train will be maintained in express service. To handle heavier trains two or more locomotives will be coupled together and will be controlled from the forward cab. The multiple control system which forms part of the equipment makes it possible for a single engineer or driver to operate several locomotives coupled together just as easily and accurately as he can handle one.

One of the valuable characteristics of the Westinghouse single-phase motor is that it may be employed on either the alternating or direct current system and it has therefore been possible for the officials of the railway company to select the most advanced and economical system for the operation of their lines, and at the same time to accommodate their equipment to the direct-current system now being installed by the New York Central Railroad, as the New York, New Haven & Hartford Railroad utilizes the tracks of the latter company between Woodland and the Grand Central Depot in New York city. For a time the service will be confined to this section and it is therefore with an eye to the future rather than present requirements that the alternating current system has been adopted.

Each locomotive will be equipped with four Westinghouse single-phase railway motors of the straight series gearless type and with the unit switch system of multiple control. On direct current each motor will be capable of developing a rated output of 400 horsepower.

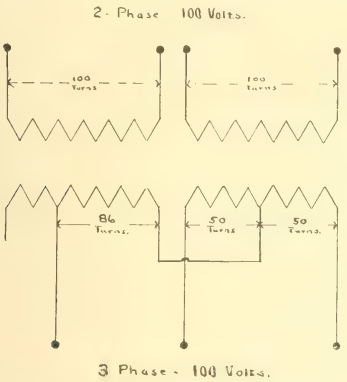
QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. NO. 1.—Will you please send me a diagram and some particulars of the Scott system of joining up transformers so as to convert a two phase into a three phase current?

ANS.—We show herewith a rough sketch illustrating the Scott method of transforming two to three phase current by means of two transformers. The sketch shows a transformation of phase only and not voltage, that is to say, the primary and secondary voltages are identical. However, the ratio will hold good for any desired primary voltage provided the number of turns shown in the sketch is increased or decreased in the same proportion that the primary voltage is increased or decreased, this same rule applying to the secondary also. There are certain electrical companies who furnish in all their large transformers, coils having a terminal brought out known as the .866 point. This is valuable when the transformers may be wanted for two to three phase work. As the Scott system consists of two phase generators, three phase transmission, and two phase distribution, such transformers are naturally used. The transformation may be accomplished, however, with two ordinary transformers, that is to say, transformers having standard taps. The transformer shown on the right hand side of the sketch will have a proper ratio of turns, but the left hand transformer in place of having eighty-six turns will have fifty turns and this will produce some unbalancing in the three phase voltage. This, however, is not so serious as to prevent standard transformers being used, and emergencies are very likely to arise where it is essential to use any kind of transformer available and under such circumstances standard transformers will temporarily give satisfactory results.



SCOTT CONNECTIONS FOR TRANSFORMERS.

QUES. NO. 2—What is meant by the "receiver" in connection with compound engines?

ANS.—The receiver is the connection between the high and low pressure cylinders. When the high pressure cylinder is exhausting, the steam is passed into the receiver, and from it in turn is delivered to the low pressure cylinder. Where the cranks of a compound engine are together or are one hundred and eighty degrees apart, the capacity of the receiver need not be large, as in this case it acts merely as a conductor of the steam from the high pressure to the low pressure cylinder. If, on the other hand, the cranks are ninety degrees apart, the receiver capacity should be much larger, authorities differing upon the exact size. For instance, Seaton says that the receiver capacity should be from one to one and a half times that of the high pressure cylinder, while another prominent engineer states that the capacity should not be less than that of the low pressure cylinder. With cranks ninety degrees apart, the receiver acts as a reservoir, and hence the necessity for its being larger than required with cranks one hundred and eighty degrees apart.

QUES. NO. 3.—I have recently received a copy of a diagram showing the horse power which a manila rope is capable of transmitting at various speeds. The curves for various diameters increase rapidly in almost direct proportion to the velocity of the rope, but after reaching a certain point the amount of power which a rope of certain size is capable of transmitting seems to drop off in spite of the fact that the velocity is still further increased. Can you give me any explanation in connection with this matter?

ANS.—When figuring manila rope for power transmission purposes, the maximum working strain which the rope is capable of standing is always taken into consideration. Let us assume that for a certain size rope this is 500 pounds. Theoretically, if this rope travelled at 5,000 feet per minute, the foot pounds would be 2,500,000, which divided by 33,000 would give the horse power. However, when the rope is travelling over pulleys, centrifugal force comes into play, and this puts a strain on the rope in addition to that produced by the driving pulley. The greater the velocity of the rope the greater this strain due to centrifugal force. This centrifugal strain must be calculated, and must be deducted from the maximum working strain which the rope will stand. If, for instance, it be 200 pounds at 5,000 feet, it will leave available for power transmission in the above case but 300 pounds. You will notice from your table that the power of the rope does not increase in the same proportion as the velocity; this is because the centrifugal strain increases with the velocity, and hence at a certain point, the centrifugal strain will equal the total strain which the rope will stand, and hence there will be no margin for the transmission of power. This point is in the neighborhood of 140 feet per second, at which point the centrifugal strain will be equal to the maximum working strain.

QUES. NO. 4.—I understand that a three phase generator can be operated as a single phase machine. Has this peculiarity any advantage and if so how much power can be obtained from a three phase generator when operated as a single phase machine?

ANS.—Probably the system which gives the best resluts so far as incandescent lighting is concerned is the single phase, and on the other hand, either two or three phase is most adaptable for power purposes. The three phase machine can be operated single phase and also three phase at the same time. This gives the three phase machine a decided advantage in small plants, as the lighting can be taken off single phase and the power taken off three phase, thus giving the best possible arrangement of circuits. As a single phase machine the three phase generator was approximately seventy-five per cent. of its three phase capacity. Where two or three phase lighting is used, difficulty may be experienced in balancing the phases, and regulators may have to be installed for the purpose. If the lighting be done from one phase of a three phase machine, this phase is the only one which will require watching, and as the voltage of this phase may be controlled without regard to the other phases, in all probability this system will give the most satisfactory results.

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Municipal Management.

In a certain city in Western Ontario we have an example of municipal ownership in one of its worst phases. We have advocated in previous issues the placing of the control of the power plants owned by municipalities, in the hands of either a commission or an individual, and the results which have been produced in certain localities have proved our contentions along this line to be correct. In the city referred to, an alternating equipment was installed some years ago, the motive power being steam. The class of apparatus which comprised the plant would be considered obsolete to-day, but in its way it was quite satisfactory and no doubt gave comparatively economical results. The plant gradually increased until an enlargement became necessary and it was at this time that trouble began. Throughout Ontario there are installed many alternating current plants, varying in size from 20 to 60 kilowatts, the distributions being within a comparatively limited area. These equipments, in the general run of cases, have been installed for ten or fifteen years, and it is quite possible that at the time of installation the use of direct current was not duly considered. Alternating current was at that time in its infancy, and its possibilities were apparently so unlimited that the introduction was greeted with a good deal more enthusiasm than it deserved. The field in which alternating current apparatus should be used is one where the amount of power is comparatively large and where the area to be covered is also on a large scale. For the little plant, with a compact distribution, direct current undoubtedly offers the most economical proposition, but the line is clearly drawn and it is not difficult to decide between the two classes of machinery. Our western concern, however, being a municipality, conceived the idea that their alternating plant was a mistake, and therefore proceeded in the wildest possible way to throw out the old apparatus and install in its stead direct current machines. Two generators, each of 200 kilowatts capacity, were purchased and were connected in series for three wire distribution, the potential across the outside wires being five hundred volts. This, we must admit, was a step in the right direction, so far as the distribution was concerned, but why two generators of such large size were installed and connected in this way is more than we can understand. The service must be on a twenty-four hour basis, during six or eight hours of which the load would be infinitesimal, and all through this period both the generators must be operated to supply energy to the corporation. To our mind the most natural thing would have been to install a small 500 volt generator either of the three wire type or with a balancer set, and use this machine to carry the light load. However, as before stated, the arrangement adopted made it necessary to operate the two large generators continuously, and the best explanation which can be given for this curious piece of engineering is that it was done under municipal ownership.

No doubt some of the councillors had heard that the efficiency of the gas engine far exceeded the best figure which could be obtained from steam engines, and this brought to the front a proposition for driving the two generators previously mentioned by means of gas. After due deliberation four gas engines were purchased, three of these machines having a capacity of one hundred and twenty-five horse power each, and the other eighty-five horse power. These engines were belted to a line shaft from which were driven the two two-hundred kilowatt generators. So far as mechanical operation was concerned, the plant was quite satisfactory, but it was not long before the corporation became aware of the fact that there was more money being spent in connection with the operation of the plant than was being received from the power consumers. This, it will be understood, was a rather serious matter, for the plant had been an expensive one to install and was so arranged that re-designing was practically out of the question. The matter, we understand, was then placed in the hands of a commission and outside assistance was employed in determining the coal operating cost of the plant and arriving at a conclusion as to the source of the trouble. So far as the generators were concerned, these machines were of high efficiency and completely fulfilled the excellent guarantees which had been given with them. The gas consumption of the engines was apparently all that could be desired. The line shaft of course required a certain amount of energy to drive it, but this was not a very serious consideration. The gas which was supplied to the engines was of a fair quality, but the great point was that this gas was costing the corporation about four times more to manufacture than was expected, and it seemed an almost impossible feat to reduce this cost. Therefore the members of the city council, after much argument, resolved upon another brilliant move, namely, that the gas engines should be thrown on the scrap heap and that substituted therefor should be steam engines of the Corliss type and boilers of modern make, such appliances having principles of operation which could be grasped by the lay mind. Gas engines cost much money, and therefore it is extremely doubtful if the Corporation would have saved one cent by this change, as they were increasing their plant cost, which was already extremely high, in order to get a decreased coal consumption, which, in all probability, they would not have obtained. However, common sense has at last ruled and they have decided to install a producer gas system. Certain members of the commission were instructed to visit and inspect various gas plants in the United States, and while the report which they submitted contains little or no information, still it may be taken whole as a favorable finding on the operation of American gas plants, but whether this report has any value from an engineering standpoint or not, the fact remains that it was adopted and the western city has made its first sensible move in the installation of producer gas. Their next step should be a modification of the electrical end, and this should be a matter of comparative simplicity. We should think that if a fifty kilowatt generator of the three wire type should be installed and so arranged that it may be driven by the eighty-five horse power gas engine, without running the line shaft, a very much better economy would be obtained from the plant as a whole. There are other similar modifications which can be made, and which will all tend to increase the economy of the plant. We sincerely hope that this city will come out of the deal on the right side, but we are inclined to think that if they should conscientiously figure the loss that has been entailed through mismanagement and improper handling, that an item of five figures at least would be placed on the debit side of their profit and loss account. And this is the city which scoffed at the idea of placing their work in the hands of a competent consulting engineer.

A great deal has been said in connection with municipal ownership in England, and figures have from time to time been placed before the public showing a really remarkable success as having come to the ventures which had been placed under the control of the local councillors. It has been stated upon good authority that two hundred and ninety-nine municipalities in England out of three hundred and seventeen have purchased businesses of various kinds and are running them under their own management. It is also stated that, not being satisfied to assume the control of one enterprise, each municipality has on the average assumed the responsibility of managing three and one-half undertakings each. It can be stated truthfully that the cost of running a business should not be more to a municipality than it is to either a private company or an individual, but with this statement must be considered the fact that the economy of any enterprise hinges directly upon its management, and therefore a proposition which may pay a private company a very handsome dividend may show a loss when placed under erratic municipal control. Due to this reason, a number of municipal enterprises in Canada have met with failure. England is looked upon as being the ideal country in which to conduct a municipal venture, but while the conditions may be ideal, still the fact remains that in placing operation cost before the public, items are omitted which should really be charged against the plant, and consequently the showing of any enterprise for a given year is apparently much better than the reality. We noted some months ago in these columns the figure given by the investigating committee in New York city in connection with the street lighting. It will be remembered that the men employed by the municipality to estimate the cost of lighting, if handled by a municipal plant, placed the figure at about sixty dollars, whereas the city was at that time paying in the neighborhood of one hundred and twenty dollars. Later it was found that several items were omitted from the cost of operation of the municipal plant, which had they been added, would have brought the total up to considerably over one hundred and forty dollars. We give emphasis to these facts to prevent misunderstanding in connection with municipal ownership. Great care should be taken in figuring the costs and the general public can be certain of one fact, namely, that it is extremely doubtful if a municipal plant can be operated more cheaply than the same plant under private ownership.

The Canadian Northern Coal & Ore Dock Company, Port Arthur, Ont., have recently purchased from the Robb Enginering Company, Limited, Amherst, N.S., one 300 h.p. Robb-Armstrong tandem engine.

The contract for the enlargement of the electric light plant of the corporation of St. Marys, Ont., was awarded on Wednesday, October 11th, by Mr. K. L. Aitken, consulting electrical engineer, Toronto. The entire equipment, consisting of a 150 k. w. revolving field generator, with panel, static transformers and series alternating street lighting system, will be supplied by the Canadian Westinghouse Company.

ELECTRIC TRACTION FOR RAILROAD SERVICE.*

By J. A. Shaw, Assistant Electrical Engineer, C. P. R., Montreal.

It is to-day generally admitted that, so far as the actual moving of trains is concerned, the electric motor can do the work better than the steam locomotive. But the more important question is, will it pay to convert steam roads to electric. This is best answered by the amount of such work which is now being carried out throughout the world, the results obtained and the advantages possessed by electric traction. These may be briefly enumerated as follows:

(1) Those appealing to the passenger, and the consequent increase in traffic.

(2) Those relating to the operating of trains from one central power house.

(3) The savings in capital, maintenance and operation.

The most noticeable to the passenger, namely, those affecting his comfort, are the cleanliness of the cars due to the absence of smoke and cinders, especially in tunnels, also the better distribution of heating and lighting made possible. Another factor is the higher speed attainable, not only for continuous runs, but with the same running speed as on a steam line, the average speed is higher and the duration of the trip reduced by the more rapid starting and stopping made possible by the increased traction due to the uniform rotary movement of motors. An additional gain in runs of considerable length would be in the abolition of stops for water or fuel.

The saving in the cost of generating power in a large central power house, with the refinements possible in steam generation and consumption as well as to the high load factor, is apparent especially as the cost of fuel increases at the more remote fuel stations on a steam road. An inferior grade of coal may also be used or if water power is available the cost of power will be very largely reduced. In spite of these advantages, it is questionable if a saving could be shown for electric traction in its present stage on a road with infrequent trains. Under present economical conditions, electricity is limited to a certain degree to large terminals, suburban lines, spurs to main lines, and mountain railways. However, the operation of through trunk lines will come shortly as the art advances and as the various water powers throughout the country are developed.

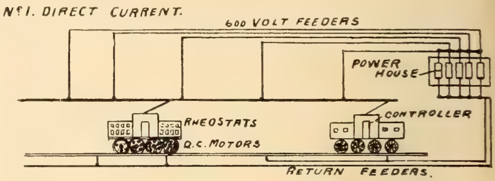
The cost of roadbed construction is in favor of electric traction, a higher grade being attainable and permitting of a shorter route. The equipment of an electric road is higher than the initial outlay for equipping the same road for steam operation; this difference is, however, counterbalanced by the larger outlay for terminal facilities and the cost of steam and water stations for a steam road.

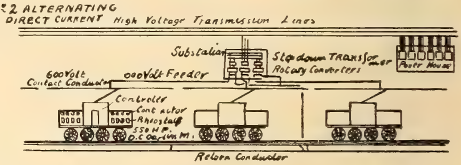
Experience has shown that maintenance and operating expenses with electric traction are much lower than with steam. This applies specially as regards track up-keep, the roadway being subjected to less wear and tear, as there is no jumping, pitching or side-way oscillation. A road with heavy traffic and a large and efficiently operated power house should use only one-half as much coal as one using steam locomotives and this may even be reduced to one-third by the application of refinements made possible with large steam generating plants. This saving, it is stated, has been made by the Italian Mediterranean Railway. On another converted road it has been observed that the cost of lubrication is now less with electric traction, and the absence of smoke results in an important reduction in the cost of cleaning. The wages of train staffs on an electrically operated road can be materially reduced, as the engineer and fireman are replaced by a motorman who does not need to go through a long and complicated training and who consequently is not entitled to so high a rate. This saving in labor, however, is questionable practice, especially where a high speed schedule is in force.

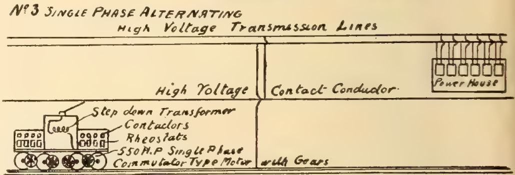
Actual figures of the comparative cost of electric and steam roads, operating under similar conditions, are difficult of obtaining as yet. It has been determined by city elevated roads that the capacity of lines has been increased by one-third, and the operating expenses reduced from more than 55% to less than 45% of its gross receipts.

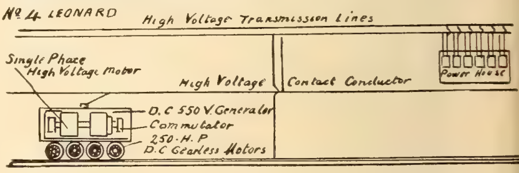
The Assistant General Manager of the North-Eastern Railway, England, stated recently in Washington, that his road had in self-defence converted a suburban service in order to regain traffic from competing tramways and to increase its amount. This they had successfully accomplished with a large increase in traffic with a resulting reduction in expenses, so that the net revenue now more than covers the interest on the extra cost of installation of new system.

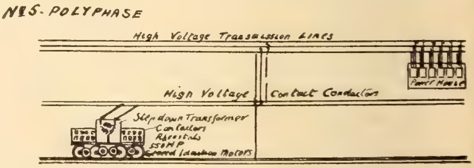
The experience of another English railway, namely, the Lancashire and Yorkshire, has been somewhat similar. This railway adopted electric traction not primarily for the sake of economy but to increase receipts and decrease the crowding of terminals. During the twelve months the line has been operated electrically, there has been increase in traffic but the cost of operation has been more expensive. The cost of coal per ton mile is greater but the running expense less because of the greater mileage run by train crews. The introduction of electricity has increased the capacity of terminals 30 to 40 per cent., due to the elimination of the time lost in handling a train upon its arrival, the electric motorcars only requiring motormen to carry operating lever from one end of train to the other, and the throwing of one or two switches is the only operation required for fitting the train for a run in the opposite direction.











Total combined operating expenses show a considerable reduction can be made in the cost of conducting transportation by the introduction of electric traction, but it is difficult to secure figures that will permit an exact analysis of each of the items which go to make up the saving.

At present there are, generally speaking, five systems available for heavy electric traction:

(1) The direct current system, such as now exists on our street and interurban lines.

(2) The alternating-direct current system, consisting of substations placed at intervals along the line to which alternating current power is transmitted at a high voltage and then lowered by step-down transformers to synchronous motors driving direct current generators feeding the trolley.

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*Paper read before the Canadian Railway Club, Montreal.

(3) The single phase alternating current system, in which single phase motors receive power from transformer sub-stations along the line which receive either high voltage single-phase or polyphase alternating current from the power station.

(4) The Leonard system, in which direct current motors are fed from motor-generators on the locomotives, the latter receiving single phase alternating current from the power station, either direct or through transformer sub-stations along the line.

(5) Polyphase system, in which three phase alternating current induction motors on the locomotive are fed from three phase transformer sub-stations along the line, which receive three phase alternating current from the power station.

Diagram herewith shows the different features of the various systems.

The advantages, disadvantages, and limitations of the various systems are as follows:

(1) Direct Current. Propulsion by direct current distribution direct is limited to short distances on account of the low limiting pressure of 600 volts, which makes the cost of copper prohibitive for heavy traction over average distances. Other things being equal, the weight of the copper required is inversely as the square of the voltage. The collection of the large amounts of current required with a larger electric locomotive, frequently amounting to 2,000 H.P. at starting, becomes extremely difficult if not impossible with an overhead feeder in a 600 volt D.C. system, so that recourse has to be taken to the third rail. The objections to the latter are so numerous and are so well known that they do not need to be gone into detail, except to mention that the third rail is likely to cause accidents to section men, increase cost of maintenance, and in case of a slight derailment, its presence might result in serious damage and the blocking of the road for a considerable length of time. It is indeed true that the wrecked portion might be isolated, as regards danger, by cutting off the current; it would also, however, to a great extent, be isolated as regards ability to bring up other apparatus for clearing the track. In fact, if the presence of a third and probably a four thrail were a necessity in connection with the introduction of electric traction, it is seriously to be doubted whether most of our railway companies would ever be brought to consider it. Other serious drawbacks, such as the comparatively large rheostatic losses occurring at the starting up of the motor, also the dangers from electrolysis, might be mentioned showing the unsuitableness of this system for heavy traction.

(2) Alternating Direct Current. In this method of distribution, the losses in transmission and the expenditure for copper are avoided by distributing alternating current at a high voltage to sub-stations placed at convenient distances, in which are installed step-down transformers and rotary converters which convert the alternating current of lowered pressures to 600 volts direct current feeding into the trolley of third rail.

This is the system adopted by the New York Central, and is the one installed by the Lancashire and Yorkshire Railway on their double tracked twenty-three mile line between Liverpool and Southport.

Alternating current three phase power is generated for this road at 7,500 volts, of a frequency of 25 cycles, and is transmitted from a power house to four sub-stations, which step-down the high tension current to low tension alternating current, from which it is converted in rotary converters to direct current, a 600 volts. This power is fed thence through feeder conductors, to the third rail, and returned from fourth rail bonded to each running rail by return feeders.

The drawbacks to the previous system apply equally to the direct current part of this system, and in addition there are the disatvantages of the sub-stations containing the direct current rotary converters, which being revolving machines require manual attendance, entailing a large initial expenditure, and a large operating staff as well as increasing liability to break down, by the introduction of another link in the electric circuit.

In view of the various disadvantages, as mentioned in the foregoing, it might be interesting to look into the reasons for the adoption by the New York Cent. Ry. of this system. The reasons for their action, it would appear, were those of policy, as well as engineering. The word policy in this respect refers to the idea that the system adopted should leave opportunity for the possible future interchange of equipment with other local systems, including the Rapid Transit lines. The relative costs of the A.C. and D.C. systems were in favor of the direct current equipment, and a further objection to the A.C system was the use of an overhead construction of bare wire in tunnels and viaducts, which included liability of injury to trainmen as well as a tendency to corrosion of wires from the gases of freight steam locomotives. Among other points, was the fact that the A.C. locomotive would have a greater weight, thus adding 7 to 10% to the train weight, with a consequent increased cost of transmission, installation, and operation of power plants. Further, the cost of maintenance of alternating current apparatus would be greater. The depreciation would also be greater, due to the equipment being more novel, and more or less untried, and would, therefore, have to be discarded in the near future to make room for improved types, whereas the direct current apparatus, being standardized, and universally in application, would prove a good asset.

(3) The Single Phase system to-day is, in the opinion of the majority of engineers, the one which is essential for heavy and long distance railway service, and conforms to the ideal requirements for electric traction. The development of the system has only become prominent and made possible within the last two years, due to the fundamental feature of the system, the single phase commntator motor, having been brought to a high degree of perfection for railway work. It should be borne in mind that the advantages accruing from this system are due primarily to the use of alternating current, rather than to any advantages of the A.C. railway motor over the D.C. railway motor, though it should be noted that it has equally good characteristics, and is almost as efficient.

The credit of the many advantages gained with this system, however, must be given to the A. C. railway motor since its development has made the exclusive use of single phase alternating current on railway systems practicable.

The details of one of the several single phase roads now operating are as follows: Power is generated at 2,200 volts, and in the power house, by means of static transformers having no moving parts, transformed to 33,000 volts. At this voltage it is transmitted to transformer stations, located every ten or twelve miles along the line, where it is reduced to 3,300 volts and fed to the trolley. The transformer stations require no attendants, as the feeder lines are all controlled from the power house, and the stations have no apparatus with moving parts. The 3,300 volt trolley current is carried into the car by a bow trolley, and through a static transformer, in the car, reduced to 250 volts for which the motors are designed. This is an extremely flexible system; by making changes in the transformers, which are not expensive and always good assets, the transmission voltage or the trolley voltage can at any time be changed to meet the requirements of new conditions which may arise. The trolley voltage could be increased to 6,000 volts, which would give sufficient power for operating one-hundred-ton locomotives, with the same size trolley wire in use. In order to protect passengers and crew from the high pressure used in this system, all car wiring is placed in metal conduits and connected to trucks, so that should any defect in insulation develop it will result in the tripping of the automatic circuit breaker in car or locomotive.

With the single phase A.C. system, the overhead conductor and its many advantages are retained. There are objectionable features to its use, some of which may be named as follows: (a) Difficulty of securing head room through tunnels under bridges as existing structures. These have been eliminated by using a third rail. (b) Snow and ice will collect on the trolley wire. This has been overcome, with more or less success, by coating wire with various solutions or greasing it, by supporting wire from underneath, and collecting current from top of wire, as is done in several Swiss installations, or by passing a heavy low voltage current through wire, raising temperature of same. (c) Poles and guy wires breaking, and allowing the trolley wire to fall, or breakage of trolley wires. These latter objections are possible to avoid by better construction, which has been introduced with the single phase railway, and consists of a catenary suspension cable or cables supported on insulators on suitable brackets from poles, trolley wire being suspended at intervals of ten to twelve feet from steel cables; this method of suspension allowing of trolley wire being kept at a uniform height above the tracks. For heavier service steel bridges spanning tracks, and carrying the suspension cables, may be used. Liability of a break occurring is reduced to a minimum by using two cables.

A summary of the principal advantages of the A. C. lectric traction over the D. C. are:

(1) Limits to trolley voltage are removed.

(2) Avoiding of rheostatic losses.

(3) No necessity for rotary converter sub-stations with manual attendance.

(4) Danger of electrolysis by return current avoided.

These and other advantages are so well recognized by engineers that this form of electric traction is now being taken up in England, Europe and South Africa, as well as on this continent. The Swedish Government railways have purchased equipment, and are making experiments with trolley voltages up to 18,000 volts, and eliminating the use of sub-stations with step-down transformers, for lowering transmission voltage to a lower trolley voltage. In South Africa the Government has recently placed an order for the equipment of one of their main lines with this system.

In order to consider more in detail the relative costs of the alternating and direct current systems, I give herewith a comparative list of costs entering into the equipment of a sixty mile interurban road where the schedule proposed requires five local cars having one hour headway; one express car making the round trip in three hours and one freight car making trip between terminals in eight hours.

Estimated Cost of the Electrical Equipment of a 60-Mile Single Track Interurban Railway.

POWER-HOUSE.	Direct Current System.	Alternating Current System.
Building	$10,000	$10,000
Foundations	2,500	2,500
Boilers and settings	12,000	12,000
Steam piping and covering	7,500	7,500
Engines	22,000	22,000
Generators	18,000	23,000
Exciters	1,000	1,000
Step-up transformers, 800-kw	8,000	7,500
Switchboard	3,500	3,000
Wiring	3,000	2,500
Feed-water heater	800	800
Pumps	800	800
Coal storage	1,000	1,000
Smoke-stack and flues	2,000	2,000
Fuel economizers	3,000	3,000
Stokers	3,500	3,500
Incidentals	4,400	4,400
Total	$103,000	$106,500

SUB-STATION IN POWER HOUSE.	Current Direct	Alternating Current
Building extensions	$ 1,000	$ 600
Synchronous converter, 300-k.w.	4,800	
Transformer, 300-k.w.; 200-k.w. alternating current	3,200	2,000
Switchboard	2,000	1,300
Wiring	1,000	500
Incidentals	600	200
Total	$12,600	$ 4,600

48-MILE TRANSMISSION LINE.	Direct Current	Alternating Current
Poles charged on trolley line		
Copper	$10,000	$11,500
Insulators, pins and cross-arms	7,500	5,000
Erection	4,000	3,000
Incidentals	1,000	1,000
Total	$22,000	$20,500

SUB-STATION ALONG THE ROAD	Direct Current	Alternating Current
Building	$2,000	$1,000
Synchronous converter	4,800	
Step-down transformers	3,200	2,000
Switchboard	2,000	1,300
Wiring	1,000	500
Incidentals	500	200
Total	$13,500	$5,000
Four sub-stations	$54,000	$20,000

TROLLEY-LINE AND FEEDERS	Direct Current System.	Alternating Current System.
Poles, 3,500	$17,500	$17,500
Poles distributed and set	4,000	4,000
Guys and anchors	2,000	2,000
Brackets with hangers	18,000	18,000
Copper, direct current:		
Feeder 12 miles, 500,000 cir. mils.		
" 48 " No. 0000		
Trolley, 120 " No. 000	95,000	
Alternating current:		
Trolley, 60 miles, No. 00		21,500
Feeder insulators	2,000	
Erection	10,000	4,000
Incidentals	7,500	4,000
Total	$156,000	$78,000

BONDING OF RAILS	Direct-Current.	Alternating Current.
Both rails bonbed	$30,000	
One rail bonded		$15,000
Cross bonds	2,000	1,000
Total	$32,000	$16,000

ROLLING STOCK	Direct Current	Alternating Current
Ten vestibuled passenger-cars, each equipped with 4 motors, and weighing about 30 tons	$75,000	$ 85,000
Two express passenger-cars, each equipped with 4 motors, and weighing about 35 tons	18,000	20,500
Two freight-cars, each equipped with 4 motors, and weighing about 30 tons	10,000	12,000
Snow-plough and construction car	7,000	8,500
Total	$110,000	$126,000

RECAPITULATION.	Direct Current.	Alternating Current.
Power House	$103,000	$106,000
Sub-station in power house	12,600	4,600
Transmission line	22,500	20,500
Sub-stations	54,000	20,000
Trolley line and feeders	156,000	78,000
Bonding	32,000	16,000
Rolling stock	110,000	126,000
Total	$490,100	$371,600

Cost per mile, direct-current system ..... $490,100/60 = $8,168
" alternating-current system. 371,600/60 = 6,193

Saving per mile, alternating-current system $1,955

The decrease of alternating-current cost in terms of direct-current investment, 25%.

The increase of direct-current cost in terms of alternating-current investment, 32%.

(4) The Leonard System is in reality a form of foregoing system, and involves the supply of single-phase current to an alternating current motor on the locomotive, motor in turn driving a direct current generator. This generator furnishes current for the operation of the car motors. By varying the voltage of D. C. generator by means of rheostat, any desired voltage may be obtained on motor supply circuit, thus allowing of the obtaining of a perfectly smooth and rapid acceleration, with minimum energy, from the supply circuit, and the starting up of a locomotive does not produce a peak in the load diagram. Such a system, while it may be feasible in the case of large locomotives, yet does not furnish a general solution of the railway problem, as the arrangement is not flexible enough. In the ideal system the same method of operation, and the same types of apparatus, should be used on the feeders or branch lines as on the main lines, if full benefit is to be obtained by electrification.

(5) The Polyphase system has been developed by European engineers, and a number of installations have been made in Europe. American engineers consistently refuse to adopt the polyphase induction motor for the following reasons, namely: (a) The motor is inherently a constant speed one, and therefore not adapted for traction work; at one definite speed only is the

polyphase motor efficient. One expedient used to overcome this is to run motors in concatenation or tandem, which gives a second speed at one-half of normal speed. By winding motors for a different number of poles, more than the two speeds may be obtained, but this arrangement has the disadvantage of being able to use but one-half of the total motor capacity above half speed, while the greatest expenditure of energy takes place above that speed. (b) The necessity of providing for at least two overhead conductors. (c) The fact that motors must be built with small air gaps to give most efficient results.

The advantages of the polyphase motor for traction purposes are as follows:

In contrast to the single phase motor, the tractive effort at starting is greater. This is due to the fact that in the single phase motor the torque is not constant, but varies between a maximum and zero, with double the frequency of the line current. The mean value of the torque is only one-half of the maximum torque when slipping wheels, which means, where the tractive effort required necessitates going to the limit of adhesion between wheels and track, a single phase locomotive must have almost twice as much weight on drivers as either a D. C. or three phase locomotive. This difference holds true only for motors mounted directly on car axles, and will be somewhat less if geared.

The weight of a three phase motor is only about three-quarters of the D.C. motor of equal capacity, and approximately one-half that of a single phase motor, and the cost is also less. The cost of equipment is also made lower, as the transformers on the locomotive may be dispensed with, as motors of this type are now made for operation direct on voltage up to 10,000 volts.

The three phase motor is probably the most robust and thoroughly mechanical piece of machinery extant, and the maintenance of same would be less than with any other system.

Generally speaking, the conditions most favorable for the adoption of this system are rare, and are when the lines are long when there are few trains with few stops, and when the lines have long and regular gradients, particularly if there is plenty of motive power and it is cheap. In the case of the mountain railways, the polyphase system has a special advantage in that power may be returned to the line when running down hill, motors acting as generators and thus allowing of the electrical braking of trains.

While the wholesale retirement of the steam locomotive in favor of its electrical competitor cannot take place in the immediate future, owing to capital now invested, there are many isolated sections of steam roads in the operation of which electric traction could effect economies which would well pay for its adoption.

These economies may be in the direction of a reduced fuel, labor, and maintenance account, but may be more far reaching, and warrant changes in the present method of operating by steam. The millions of dollars contemplated for reducing grades, and double tracking certain sections of single track roads in order to increase their capacity with steam locomotives, might be spent with promise of a greater return if used for installing electrical equipment.

The whole situation as regards electric traction is excellently summed up in a few words spoken by Mr. George Westinghouse, during the opening exercises of the American Railway Appliance Exhibition held in Washington in connection with the International Railway Congress. He stated the case as follows:

" A new era in railway operation has dawned with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive, that it requires no great prophet to predict the extensive growth of electric traction upon the great railways of the world, and the eventual replacement of the steam locomotive. Fortunately, the time element, which is such a controller of events, and the financial problems involved, will ensure gradual development and extension of the use of electricity.

"With these changes have come vastly different engineering problems and new sources of danger, which should and will command and receive that attention which is essential to the surmounting of every difficulty as it arises."

A by-law will be submitted to the ratepayers of Fort Frances, Ont., to provide funds for the installation of an electric light plant.

AMERICAN STREET RAILWAY ASSOCIATIONS.

The annual conventions of the American Street Railway Association, the American Railway Mechanical and Electrical Association, and the Street Railway Accountants' Association of America, were held at Philadelphia, Pa., during the week commencing Sept. 25th. Hon. W. Caryl Ely, president of the Street Railway Association, delivered a lengthy and interesting address, in which he explained the proposed plan for the reorganization of the association upon broader lines.

A large number of very interesting papers were read, including the following: " The Single Phase Railway System," by Charles F. Scott. The author stated that the single phase railway system decreases the cost of installation and operation for the kind of interurban service which has been successfully developed by the direct current, and it extends the field of commercial operation to include, on the one hand, rural roads with comparatively light traffic, and on the other, a heavy infrequent multiple unit for locomotive service for passenger or for freight approximating steam railway conditions. Mr. J. I. Bibbins, in a paper on " The Application of Gas Power to Electric Railway Service," discussed the adaptability of the gas engine and producer plant to meet the severe requirements. He presented a number of very interesting load curves. Mr. Arthur West read a paper on " Notes on the Design of Large Gas Engines with Special Reference to Railway Work." He stated that the thermal efficiency of the gas engine is about 25 per cent., though efficiencies well over 30 per cent. have been obtained. The large size gas engine had come to fill such an important place in Europe that there is no question about its being adopted on this Continent in the near future, in a form suited to American operating conditions.

The American Street Railway Association will hereafter be known as the American Street and Interurban Railway Association. Mr. Ely was re-elected president.

Before the American Railway Mechanical and Electrical Association, Mr. C. H. Hile read a paper on "Power Distribution", in which he described the system of the Boston Elevated Railroad Company. "The Power Station Load Factor as a Factor in the Cost of Power" was the subject of a paper by Mr. L. P. Crecelius. He showed the advantage of interconnecting several stations by means of bus-bars and shutting down certain ones completely during periods of light loads. Two papers relating to controlling apparatus were presented as follows: " Multiple Unit System of Train Control," by Mr. Hugh Hazelton, and "Series Parallel Railway Controller", by Mr. W. A. Pearson.

SETTLERS LOW RATE WEST.

The Chicago and North Western Railway will sell low one way second class settlers tickets, daily from Sep. 15th to Oct. 31st, 1905, to points in Utah, Montana, Nevada, Idaho, Oregon, Washington, California and British Columbia. Rate from Toronto to Vancouver, Victoria, New Westminster, B. C., Seattle, Wash., or Portland, Ore., $42,25; to San Francisco or Los Angeles, Cal., $44.00. Correspondingly low rates. Best of Service. For full particulars and folders write to B. H. Bennett, General Agent, 2 East King St., Toronto, Ont.

W. K. Lowden, St. Lambert, Que., has recently purchased from the Robb Engineering Company, Amherst, N.S., two 100 h.p. boilers and one 150 h.p. engine for sewer pipe works.

Some advertisers make space yield a large income. Others can't make it yield what it cost them to buy it. It's what you put in it that makes the difference.—Rhode Island Advertiser.

The Southern Light & Power Company have offered to supply electric light to the village of Weston, Ont., at $6 per 32 c.p. light per year, for an all-night service. This company are now lighting the village of Streetsville.

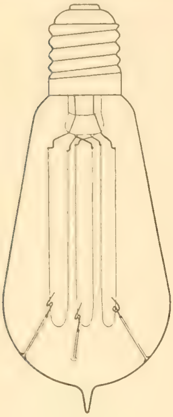
J. R. Booth, Ottawa, has recently purchased from Robb Engineering Company, Limited, Amherst, N.S., two 400 h.p. Robb-Armstrong Corliss engines, one 350 h.p. Robb-Armstrong Corliss engine and three 100 h.p. Robb-Armstrong Corliss engines. This machinery is for Mr. Booth's new paper mills.

The Town of Napanee, Ont., have recently purchased from Robb Engineering Company, Amherst, N. S., two 200 h. p. Robb-Armstrong Corliss engines, two 120 h.p. return tubular boilers, and one 200 h.p. "Robb" feed water heater. This machinery is for their new municipal lighting plant.

INVENTION and DEVELOPMENT

IN THE ELECTRICAL FIELD

The Osmium Lamp.—The Osmium lamp, which is the invention of Dr. Carl Ritter Auer von Welsbach, the inventor also of the incandescent gas mantel known in this country under the name of Welsbach mantel, and on the Continent under the name of the Auer mantel, is on the market of Great Britain and Germany. The illustration shows a 50-volt, 25-c.p. lamp, guaranteed at 1.5 watts per c.p. The filament, which has an approximate length of 15 in., is divided into three separate loops which are connected in series by means of two loops of platinum wire, the middle of each of which is fused by means of a glass head to the top of the stem carrying the two leading-in wires. Each filament is anchored in order to prevent the loops from touching. The anchoring device consists of a small glass rod, to the end of which is attached a turn of small wire of white refractory material, as shown in the illustration. Formerly these anchor terminals were made of metal, but as it was found that the filament always parted at this point the refractory material was substituted. It will be seen that the filament is anchored, not at its extremity, but somewhat above the turn of the loop. The lamps can be burned only in a vertical position. During the first 200 hours of burning, or thereabouts, there is a slight increase of candle-power due to particles of osmium being fused together by the current passing through the filament. At the end of this period the candle power reaches a maximum and decreases afterward. It was at one time stated that the actual life of the filaments might be as high as 5,000 hours, but that the useful life is only 2,000 hours, by useful life being understood the time during which the candle-power maintains 80 per cent. of its initial value. The English company, however, guarantee a life of only 500 hours at a consumption of 1.5 watts per candle.

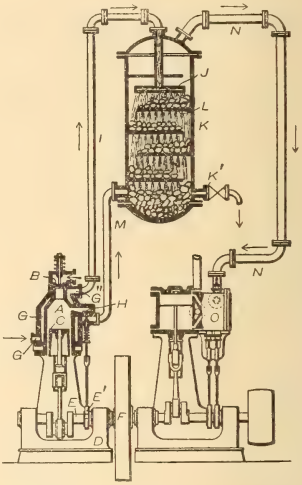


THE OSMIUM LAMP.

An Interchangeable Transformer.—The Wagner Electric Manufacturing Company, of St. Louis, are now placing upon the market types M. and M. H. oil filled interchangeable transformers for both lighting and motor service. These transformers embody literally two in one. The three important claims made for them are as follows:—First: The same regulation on unbalanced three-wire load as on two-wire load. Second: Satisfactory regulation on lighting and motor load in combination. Third: A complete interchangeability for lighting and motor service, without the introduction of special taps for changing ratios.

500 H. P. Diesel Engine.—At the International Exhibition at Liege, Belgium, there was exhibited a 500 h. p. Diesel engine built by the Societe Anonyme des Ateliers Carels Freres, of Ghent. It is intended to operate at 150 r. p. m., and is direct coupled to a Lahmeyer generator. The engine has three cylinders, the three cranks being placed at an angle of 120° from each other. Forced lubrication is used for the piston and piston rod, and automatic ring lubrication for the bearings. The temperature of the cooling water is kept at about 70° C.; as is usual with this type of engine, compressed air is used for starting, only two of the cylinders being used for this purpose. The fuel consumption is most economical, crude Texas oil of specific gravity 0.925-0.930 being used. This is the largest Diesel engine yet built.

Combination Gas and Steam Engine.—For the utilization of the energy contained in the exhaust gases of internal combustion engines, The Engineer says that the invention shown in the accompanying cut was patented by Arkadius Houkowsky. In the apparatus shown, *A* is the high-pressure cylinder with a valve *B* for the admission of the explosive mixture. *C* is the high-pressure piston connected with a crank *D* on the main shaft *E*, which also carries the flywheel *F*. *G* is the water jacket on the high-pressure cylinder, having an inlet at G^1 and an outlet at G^2, and *H* is the exhaust-valve of the high-pressure cylinder, this valve being controlled by an eccentric E_1 on the main shaft. From the cooling jacket the water passes through a pipe *I* to a sprayhead *J*, located within a casing *K*. This casing also contains a series of shelves *L*, arranged in baffle-board fashion and supporting loose material of large surface, such as pieces of coke. The water from the sprayhead *J* travels downward over the shelves and the material thereon and finally escapes at the bottom through an outlet K^1. From the high-pressure cylinder the exhaust gases pass through a pipe *M* to the bottom of the casing *K* and then travels upward in the casing. The gases and the water are thus brought into intimate contact and are caused to exchange their heat, and by proper proportioning of the amounts of water and exhaust gases, a large portion of the water may be converted into steam. This steam together with the exhaust gases which have been purified by contact with this water, passes from the top of the casing *K* through a pipe *N* to the steamchest *O* of the low pressure cylinder *P*, adding in this way to the power of the engine.



COMBINATION GAS AND STEAM ENGINE.

TELEGRAPH and TELEPHONE

ORGANIZATION OF TELEPHONE COMPANIES.

A convention of representatives of independent telephone companies was held in Toronto last month, the meeting being called to order by Mayor Urquhart, of Toronto. Mr. A. F. Wilson, who was the moving spirit in the convention, was appointed secretary pro tem.

Among those present were the following: Alph Hoover, Green River (Markham and Pickering Co.); H. S. Milne, Brown's Corners (Scarboro Telephone Co.); Dr. W. Doan, C. B. Adams, W. J. Coates, Wm. Barr, Harrietsville (Harrietsville Telephone Association, Limited); A. R. Walsh, Orono, and S. S. Hallowell, Starkville (East Clarke Phone Line); John A. Sprague and J. S. Sprague, Demorestville (Sprague Co.); F. D. McKay, M. H. Ludwig, and S. B. Allan, Toronto (Canadian Machine Telephone Co).; Geo. Nealy, Dorchester, A. D. Bruce, Gormly (Bethesda and Stouffville Co).; F. Dagger, Ottawa; R. Y. Ellis, Toronto; D. J. Johnston, Chicago (Lorimer Automatic Telephone Co.); M. McPherson, C. Heinz, Brantford (American Machine Telephone Co).; J. Gibson, Rochester (Stromberg Carlson Telephone Mf'g. Co.); Alex. Neilson, Brown's Corners (Scarboro Telephone Co.); M. H. Oversolt, Jordan (Lincoln Telephone Co.)

Mayor Urquhart referred to the recent enquiry at Ottawa into telephone matters, which had brought to the attention of the public the large number of independent companies doing business with profit to their subscribers. He thought the future would bring about the ideal state of Government ownership of trunk lines and municipal management of local branches.

The report of the committee on resolutions urged up on the Dominion Government the consideration of the nationalization of the long-distance lines, and the giving of access thereto to all telephone organizations doing business in Canada. The Government was also requested to pass such legislation as would prevent any exclusive contracts between telephone and transportation companies, and compel the latter to give access to their premises to all telephones, no charge for installing a 'phone in any station being permitted. Municipalities and independent companies were warned against making special agreements with or giving exclusive franchises to any company before the final report of the special Parliamentary Committee is made on the question. The Dominion Parliament was congratulated on the active interest its members had taken in telephone matters, and it was hoped the enquiry would be continued next session.

It was decided that the official name of the association should be the Canadian Independent Telephone Association, with headquarters at Toronto. The membership was confined to representatives of municipalities and shareholders in independent companies, two members only from each being allowed to vote at meetings. The offices to be filled were president, vice-president, secretary-treasurer, and an Executive Committee of nine members.

The following officers were elected: President, A. Hoover, Green River; vice-president, F. D. McKay, Peterboro; secretary, A. F. Wilson, Markham; executive committee, Dr. Demers, Quebec; Dr. Doan, J. A. Sprague, Demorestville; T. A. E. Esterbrook, St. John, N.B.; Dr. Oches, Hespeler; Mayor Vickers, Port Arthur; Dr. Hart, Brantford; Levi Moyre, Beamsville, and C. J. Thornton, Kerby.

A HYDRAULIC LONG DISTANCE TELEPHONE.

Prof. Quirino Maiorana, an Italian scientist, has been engaged for some time in perfecting a hydraulic telephone, and has succeeded in transmitting speech distinctly from Rome to London. The successful results of this experiment have been confirmed recently, when the London General Post Office was able to understand clearly whatever conversation was transmitted from Rome. The success of this experiment is the more remarkable as the telephone line, Rome-Parish-London, apart from its lengths, includes submarine cables in the channel, so that this achievement can be said to be the most important telephone transmission ever obtained up to now.

SHORT CIRCUITS.

The ratepayers of Dauphin, Man., have voted in favor of a municipal telephone system.

The Miramichi Telephone Company, Chatham, N.B., have sold out to the Central Telephone Company.

The Hinton Electric Company, of Vancouver, B.C., have just completed a telephone system for Vernon and vicinity, carrying 125 telephones.

The ratepayers of Port Arthur, Ont., will vote on a by-law on October 16th to raise $18,000 for erection of a telephone building and extension of the system.

The Bell Telephone Company have recently completed a copper metallic line from Doucet's Landing to Nicolet, Que. This forms a direct circuit from Montreal to Three Rivers.

The Bell Telephone Company have been given a renewal of their franchise at St. Catharines, Ont., for five years. Free telephones will be installed to the amount of $475.50 and a $400 cash bonus given.

Messrs. L. E. Carson, electrical engineer of the American Telephone Company, and S. P. Young, superintendent of construction, are making a survey for a direct telephone line between Kingston, Ont., and Watertown, N.Y. At present the telephone connection between these two places is secured in a roundabout way by Ogdensburg.

The Central Telephone Company, recently granted a charter by the New Brunswick Government, is destined to become an important factor in the telephone business of the province. They have already acquired the local system at Chatham, Richibucto, Bathurst and Campbellton. The intention of the promoters is to have a trunk line with which the various exchanges will be connected, and extensions will be made to secure connection with Montreal.

The Okanagan Telephone Company have had a complete telephone system installed in Vernon, B.C. The Hinton Electric Company, of Victoria, had the work in hand, the installation being done under the direct supervision of their Mr. Robert Jamieson. The system will cover the business section of the city and include a great many of the residences. A 100 drop switchboard is in use and everything in the central station is arranged to provide for expansion.

Mr. B. S. Jenkins, general superintendent of C.P.R. telegraph lines in the West, states that his department are getting ready to protect the company's interest between Winnipeg and Fort William wherever blasting operations are going on in connection with the double tracking of the road. Many miles of cable will be necessary and the present poles and wires will be taken down. Work that might not interfere with the passage of trains would paralyze the telegraph. Good progress has been made in stringing the new copper wire from Winnipeg to the Coast. Some delay was caused by an iron wire ordered from Germany becoming damaged by soft water while crossing the Atlantic, making it necessary to re-order.

WESTINGHOUSE PREPAYMENT WATTMETERS.

Most consumers of electrical energy prefer metered service to the payment of flat rates, but there are always a large number who are not prompt in the payment of bills and who cause much trouble for the collection department. In many cases these customers are not financially responsible, and in the course of a year the loss to the operating company amounts to a considerable sum. With metered service it is impossible to arrange for payment in advance, and the problem of insuring protection to the company furnishing energy was unsolved until the advent of the prepayment integrating wattmeter. Not only will this meter insure the lighting company against the nonpayment for energy used, but offers advantages to the consumer as well. There is no possibility of error in bills due to carelessness in taking meter readings, and the resulting complaints from consumers are eliminated. Customers are also relieved of the trouble and time necessary to go to the office to pay bills, or the annoyance of a collector, and the expense of his services to the lighting company are dispensed with.

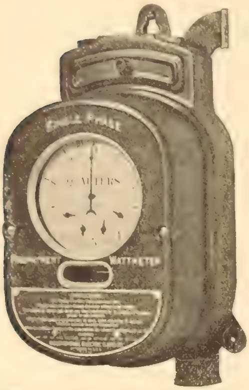


Fig. 1. Single Phase Prepayment Wattmeter.

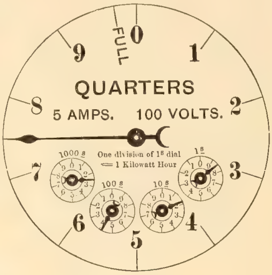


Fig. 2.—Dial.

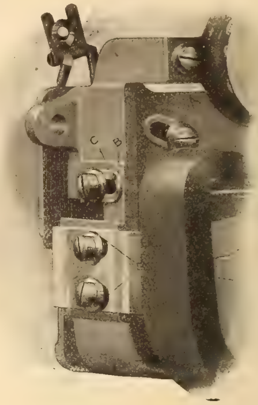


Fig. 3.—Adjustments.

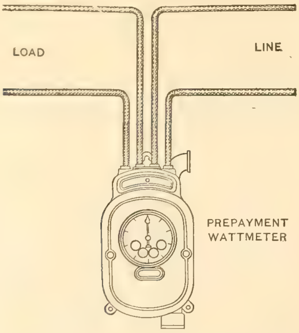


Fig. 4.—Two Wire Prepayment Wattmeter.

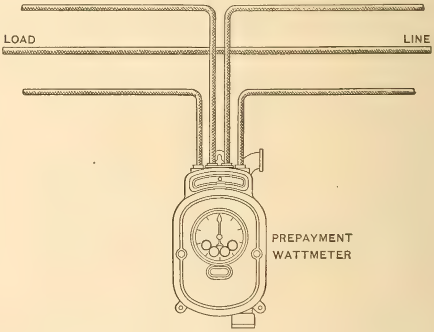


Fig. 5.—Three Wire Prepayment Wattmeter.

DIAGRAM SHOWING CONNECTIONS TO CIRCUIT.

The prepayment meter has great usefulness in such fields as sign lighting and window illumination for stores. By inserting the proper number of coins the sign, display window, arc lamp or other device may be automatically extinguished at a predetermined hour, thus obviating the necessity of a watchman's services to perform this duty, or placing time switches. In this manner a separate account of the display may also be kept. In automobile garages prepayment wattmeters may be used to great advantage with Cooper-Hewitt charging outfits and motor-generator sets.

The Westinghouse prepayment integrating wattmeter is similar in mechanical and electrical details, with the addition of the prepayment feature, to the operating mechanism of the Westinghouse type B watt-meter. The addition consists essentially of a circular dial and pointer, a coin slot and a circuit closing mechanism. When a coin is inserted in the slot it strikes a wheel, releasing a spring which closes the circuit through the electro magnet of a switch connected to the main circuit. The appearance of both the two and three-wire single phase meters is shown in Fig. 1.

The coin dial is plainly marked in ten divisions, each division representing a quarter of a dollar, that being the size of coin for which the meter is designed. One or more quarters up to ten may be inserted at one time, the amount of current paid for being indicated by the position of the pointer. In Fig. 2 the pointer stands between 7 and 8, and if a quarter were dropped in, the large pointer would at once assume a corresponding position between 8 and 9. The pointer is so connected with the train of gears that records the consumption, as indicated on the four smaller dials, that as the current is consumed the large pointer travels backward until the amount paid for is entirely used and the pointer reaches zero, when the current is automatically cut off. In the dial shown the consumer has nearly seven and one-half quarters to his credit, or about $1.88. An ingenious arrangement is provided whereby any coin smaller than a quarter will pass through the slot without operating the mechanism. The coin receptacle will hold a total of forty quarters. The meter can be adjusted for any rate met with in common practice, that is, from 10c. to 25c. per kilowatt-hour, varying by increments of one cent. The meters as shipped are arranged for a definite rate which the customer himself may change by ordering a new shaft on which the first counter is mounted. The kw. capacity or current and voltage marking of the meter and the rate per kw. hour must be given when ordering rate changing parts. The shaft can readily be taken out by removing an adjustable bracket from the back of the dial mechanism. The covers of all meters are sealed to guard against being tampered with.

The adjustments of the Westinghouse prepayment meters are shown in Fig. 3. Moving the magnets in from the edge of the disc will increase the speed and moving them out will decrease it at any given load. By loosening the screws at D the magnets may be moved as required. Compensation for friction may be made by means of the screw at A. Meters which are calibrated for circuits of 16,000 alternations per minute are so arranged that they may be changed to operate on 7200 alternations by moving the slide C.

Westinghouse prepayment wattmeters may be obtained for either two or three-wire single-phase circuits. The two-wire instruments are manufactured in six styles for 50 or 100 volts—5, 10 or 20 amperes; the three-wire instruments in three styles, for 100 volts—5, 10 ar 20 ampers. The counters in both two and three-wire instruments record the exact amount of energy supplied to the circuit, and no multiplier or constant is necessary.

MOONLIGHT SCHEDULE FOR NOVEMBER.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Nov. 1	5 20	Nov. 2	6 00	12 40
2	5 20	3	6 00	12 40
3	5 20	4	6 00	12 40
4	10 40	5	6 00	7 20
5	11 40	6	6 00	6 20
7	0 40	7	6 00	5 20
8	1 30	8	6 00	4 30
9	2 30	9	6 00	3 30
10	3 30	10	6 00	2 30
11	No Light	11	No Light	
12	" "	12	" "	
13	5 10	13	7 40	2 30
14	5 10	14	8 20	3 10
15	5 10	15	9 10	4 00
16	5 10	16	10 00	4 50
17	5 00	17	10 50	5 50
18	5 00	18	11 50	6 50
19	5 00	20	1 00	8 00
20	5 00	21	2 00	9 00
21	5 00	22	3 10	10 10
22	5 00	23	4 20	11 20
23	5 00	24	5 30	12 30
24	5 00	25	6 20	13 20
25	5 00	26	6 20	13 20
26	5 00	27	6 20	13 20
27	5 00	28	6 30	13 30
28	5 00	29	6 30	13 30
29	5 00	30	6 30	13 30
30	5 00	Dec. 1	6 30	13 30

Total............239 40

MR. W. A. SWEET.

Mr. W. A. Sweet, of Hamilton, chief engineer and station superintendent for the Hamilton Cataract Power, Light and Traction Company, whose portrait appears on this page, was elected president of the Executive Council of Canadian Association of Stationary Engineers at the convention held in Chatham on August last. Mr. Sweet first served his apprenticeship as a miller in the Woodburn Mills, during which time part of his duties were to look after the engine and boiler. The engine was one of the old Beam type. After serving four years in this position he entered the engine shops, but four years later returned to stationary engineering. He operated some of the best plants in and around the city of Hamilton, his engineering ability having placed him in the ranks of the best engineers in the Dominion.

The stations of which Mr. Sweet is now superintendent are four in number, the principal one being located on Victoria avenue and having an auxiliary steam plant of 3,000 h.p.; transformer capacity of 12,000 k.w.; storage battery plant of 264 cells or 410 k.w. hours; two railway motor generator sets of 1,000 k.w. each; and one motor generator for direct current service of 375 k.w., also alternating power service and incandescent and alternating arc lighting services.

MR. W. A. SWEET, Hamilton,
President of the Canadian Association of Stationary Engineers.

In sub-station B, which is located in the east end of the city, there is transformer capacity of 12,000 k.w., which supplies the eastern portion of the city with power and light. This station has one 275 k.w. motor generator set for supplying power to railways, while at Burlington Beach there is a 500 h.p. steam driven railway generating plant. Mr. Sweet has also under his supervision the company's steam heating plant for the offices, warehouse and store-rooms. From this plant is also heated the large stone hotel known as the "Victoria," which is adjoining the company's property.

The Canadian General Electric Company have acquired additional property at Peterboro for the purpose of extending their works. It is understood that upwards of $300,000 will be expended in making additions to the wiring and lamp building, machine shop, brass foundry, transformer building and blacksmith shop. A new building will also be provided for the manufacture of Curtis steam turbines.

GOLDIE & McCULLOCH CORLISS ENGINES.

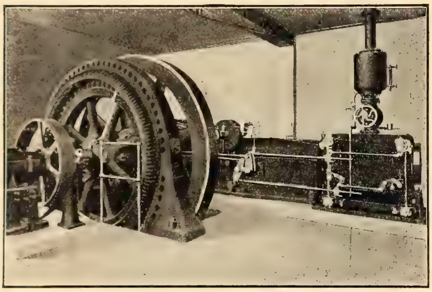
The Goldie & McCulloch Company, Limited, of Galt, have recently entered into the manufacture of Corliss engines, and the following description is of their standard heavy duty engine, which has been designed particularly for direct connected electrical work, having in view the peculiar difficulties which this work presents.

The frame is of very plain but pleasing appearance, being of the box pattern with all ribbing inside. As it is cast in one piece and supported for its full length on the foundation, there is no possibility of its springing under severe strains of great and sudden changes of load. The bearings are babbitted and are of the four part type with wedge adjustment on both sides. The outside of the shells are turned and the frame casting bored to suit. This permits of an easy removal of the bottom shell by raising the shaft about one-eighth of an inch and rotating the shell around the shaft. The crank pit has a cast iron bottom forming a reservoir into which the waste oil from all parts of the engine can be conducted and drained off.

Out board bearing is ring oiling and babbitted. It rests on heavy cast iron wedges, which in turn are supported by a massive base which reaches to the same level as the bottom of the engine frame. The wedges permit of a vertical adjustment of the whole outer pillow block, while heavy set screws are provided to take care of a certain amount of horizontal movement.

The shaft is of open-hearth forged steel, with large fillets where there is a change of diameter.

The cranks are of the counterbalanced disc type, and are made of semi steel. The pin is of large size and of open-hearth steel, ground into the crank to a taper fit, shrunk in and secured by a thin nut at the back. The pin is case-hardened and ground to a perfectly true surface.



Goldie & McCulloch Corliss Engine.

The connecting rod is of solid end type with adjusting wedges which enter the side of the rod and are so placed that in taking up the wear the length from centre to centre remains constant. This arrangement of wedges renders them easily accessible, especially at the crosshead end ; it secures greater strength at the ends from the fact that nothing is cut from the section of the rod as with a vertical wedge, and gives a wedge which has a bearing the full width of the box. The whole rod is strong, simple and convenient.

Crosshead is made of semi-steel of the box pattern and fitted with babbitted shoes, which are adjustable by wedge and screws. The shoes are turned to fit the guides which are bored circular and central, with the piston rod allowing of perfect alignment. The pin is open-hearth steel with a taper fit in the crosshead, and is case-hardened and ground to a true surface. The piston rod is screwed into the crosshead and secured by a heavy nut. The shoe is held from moving lengthwise on the crosshead by an end plate, which maintains the pin in a central position with regard to the shoe at all times. By taking off this end plate the shoe can be removed without disturbing the crosshead.

Cylinder is cast of hard, close-grained iron. The end next the frame is cast closed. This prevents the necessity of having a steam joint next the frame. The advantage of this is apparent, for, in event of such a joint leaking, it would be necessary to remove the entire cylinder to render it again tight. The exhaust passage is separated from the cylinder barrel by a dead air space, avoiding loss of heat by transfer due to the differences of temperature of the steam in the cylinder and the exhaust. The valves are double ported, insuring ample port opening with small angular travel and consequent minimum of wear. The valve seats are first rough bored, then reamed out with a spiral reamer, and finally lapped out to gauge and a perfect surface. The valves are ground to gauge. This gives a steam-tight contact between valve and seat at the outset and it is not necessary to run the engine some time before the leak past the steam valve disappears. The edges of the valves are milled straight, and the edges of the cylinder ports are planed by a special device, eliminating any chance of wire drawing of steam by reason of the valve and port edges not lining. The steam valves are relieved at the back, permitting them to rise from their seats in event of an accumulation of water in the cylinder, thus allowing it to escape. The steam pressure on all the valves is normal to the seat, which allows the valves to automatically take up the wear and remain tight indefinitely.

Radiation of heat is prevented by a coat of non-conducting material over which is placed a lagging of sheet steel. A heavy cast iron base plate, with raised edges, is placed under the cylinder, allowing all drips from the cylinder and valve gear to be collected and drained off. The dash pots, which are of the vacuum type, are fastened to this base plate.

Combination, relief, drain and indicator cocks are placed at each end of the cylinder.

The piston is of the box type, and is made with a broad junk ring, which is the full width of the piston. This carries a single packing ring of self-adjusting type.

The valve gear is operated by two eccentrics—one operating the steam valves and one the exhaust valves. The chief advantage of this arrangement is that the governor maintains control of the cut-off up to three-quarters stroke, instead of losing the control before half stroke, as is done with a single eccentric engine. An additional advantage is that the exhaust valves can be adjusted to open and close the exhaust at exactly the proper time. The steam valves are driven direct from the eccentric without a wrist plate. The exhaust valves are driven through a combination of short links and cranks, which gives the same effect as a wrist plate. As this whole motion is supported on the bonnet itself, there is no toggle strain tending to push the bonnet sideways, as there is with a wrist plate. The wearing surfaces are large, and the hardened steel latch plates have eight wearing surfaces, and are provided with a means for adjusting the amount by which one plate laps the other when hooked in. The valve stem lever is keyed to the spindle and is also split on one side and clamped, thus making it impossible for it to become loose. The lever is placed inside the bonnet, which brings it close to the valve and correspondingly reduces the effect of twisting action on the spindle. The device for unhooking the motion from the eccentric rod in order to operate the valve gear by hand is very simple. By rotating the small handle half a revolution, the reach rod is permitted to block.

The dash pots on engines running up to 120 revolutions are of the vacum type. Above this speed they are steam actuated.

The governor is the "Rites" Inertia Governor, and is fully covered by patents. The particular features of this governor are its quickness and sensitiveness due to the use of inertia, coupled with small friction and strain of work of tripping the valve gear. While the degree of regulation is much superior to the ordinary type of governor the steadiness is a feature, there being no tendency whatever to "race." For the parallel running of engine driven alternators of high frequency, this governor is particularly adapted.

T. W. Page, an Englishman employed by the Bell Telephone Company, Montreal, was killed by a live wire while making repairs to the line on Latour street. Upon reaching the top of a pole he is said to have come in contact with an unprotected wire, which hurled him to the ground below, a distance of 40 feet. Death was almost instantaneous.

The Canadian Westinghouse Company are supplying and installing all the necessary electrical apparatus for the new General Hospital at Vancouver, B.C. The equipment includes one 50 k. w. 125 volt compound wound direct current engine type generator, one 25 k. w. 125 volt compound-wound direct current engine type generator; one 11 x 12 direct connected Ideal engine, and one 9 x 10 direct connected Ideal engine, besides switchboards, etc. This plant will generate electricity sufficient for 1500, 16 candle power lamps.

SPARKS.

A by-law was recently carried by the ratepayers of Parry Sound, Ont., providing $20,000 for improvements to the electric light plant.

It is reported that the Carleton Electric Light Company, of St. John, N.B., will apply to the Legislature for permission to build an electric railway along certain streets.

The Hamilton Cataract Power, Light & Traction Company have been given a franchise for electric lighting in St. Catharines, Ont. They agree to expend $150,000 in extending their plant at DeCew Falls.

The Southwestern Traction Company, of London, Ont., have purchased a site on which to build a reserve power house. The structure will be of steel frame, with concrete walls, and probably of tower design.

The ratepayers of Chatham, N.B., have authorized the Council to issue bonds for $35,000 to install an entirely new electric light plant. It was considered that the results in the end would be more satisfactory than by remodelling the present plant.

Foley, Lock & Larsen, Winnipeg, are putting in two 62½ k.w. direct engine type Westinghouse generators, with twenty-two motors of various sizes. Mr. W. Skinner, the Winnipeg representative of the Westinghouse Company, is looking after the installation.

The Ontario Power Company are reported to have contracted with an American manufacturing concern in New York state to supply 30,000 horse power at $12 per horse power per year. The Plymouth Cordage Company, of Welland, Ont., will be supplied with 1,200 horse power at $15.

A well known electrical man remarked the other day that he had never come across an electric wireman from Ireland. Why is this, in view of the large number of Englishmen coming to Canada who claim to be wiremen? The latter are said to be as a rule very inefficient workmen.

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George Stamp and David Ross, electrical contractors, Winnipeg, have dissolved partnership, and the business will be continued by Mr. Stamp under the name of the United Electric Company.

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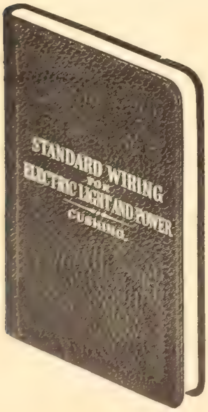

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SPARKS.

The Town Council of Uxbridge, Ont , are looking into the question of lighting and may submit a by-law to the ratepayers to raise money to acquire a municipal plant.

Mr. William H. Moore has outlined a scheme for the building of an electric railroad from New Westminster, B.C., to Spencer's Bridge on the south bank of the Thompson river, nearly 100 miles.

The Maritime Coal and Railway Company have in contemplation the installation of a large steam plant at the mines for the purpose of supplying Amherst, N. S., with power. The power will be generated at Chignecto and transmitted to Amherst, a distance of six miles.

It is reported that as the result of the contest between the St. John Railway Company and the Carleton Electric Company, of St. John, N. B., a new company with a capital of $200,000 will be formed for the purpose of building a large power house and furnishing light and power throughout the city. It is being promoted by the Carleton Company.

The Robb Engineering Company, Amherst, N. S., have been given the contract for supply of engines and other accessories for the electric light plant at Westmount, Que., their tender being $8,300. The Custodis Chimney Construction Company, of New York, will build a chimney for the same plant, 150 feet high and 6 feet in diameter at the top, at a cost of $6,250.

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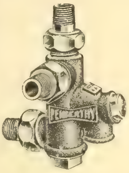

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SPARKS.

It is announced that the Vancouver Power Company will still further increase the capacity of their plant at Lake Beautiful by the addition of another 1,500 k.w. unit and by the construction of another pipe line. A Pelton water wheel, operating at 225 r. m., under 390 feet head, will also be installed.

The Canadian White Company, Limited, Montreal, have been awarded the contract for erecting the new head office building of the Federal Life Assurance Company in Hamilton, for which Messrs. Finley & Spence, of Montreal, are the architects. The building will be 8 stories, of modern steel construction, and is to be completed by August 1st, 1906. The same company have also secured the contract for the new car sheds of the Montreal Street Railway Company.

The purchase of an electric plant to furnish the necessary arc and incandescent lighting for Toronto Island is under consideration by the City Council. The Ontario Legislature gave the city power to spend $40,000 for this purpose, but the City Engineer has reported that this amount is not sufficient to install the necessary plant.

The Town Council of Goderich, Ont., received the following tenders for supply of 125 5-ampere two-wire meters: Packard Electric Company, St. Catharines, $10.75; Canadian General Electric Company, Toronto, $10.95; John Forman, Montreal, $11.75; R. E. T. Pringle Company, Montreal, $11.90. It was decided to divide the order, taking fifty from the Packard Company, who were the lowest tenderers, and twenty-five from each of the other companies.

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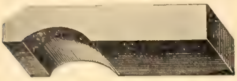
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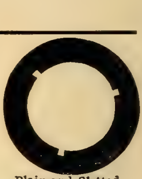
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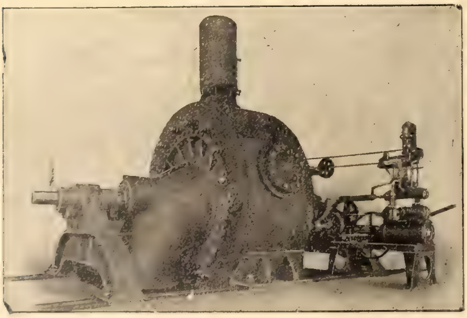

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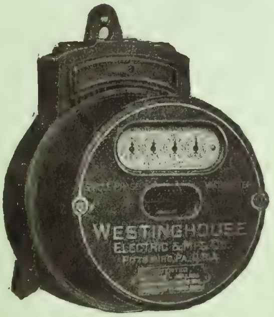

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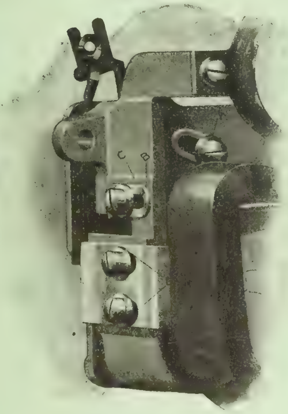

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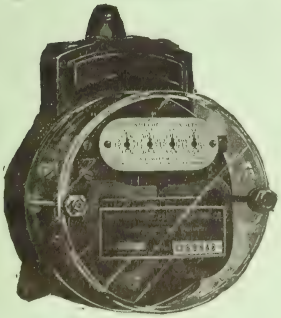

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If by any accident the calibration of the Type "B" is destroyed, it can be readily readjusted by moving the slide which will give the adjustments desired. The center illustration shows these adjustments (see letter A,B,C,D.) It will be noted they are all mechanical sliding adjustments secured by set screws, which can be readily reached by removing the cover. There are no soldered adjustments with danger of damage from acid fumes.

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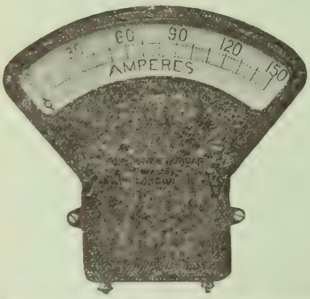

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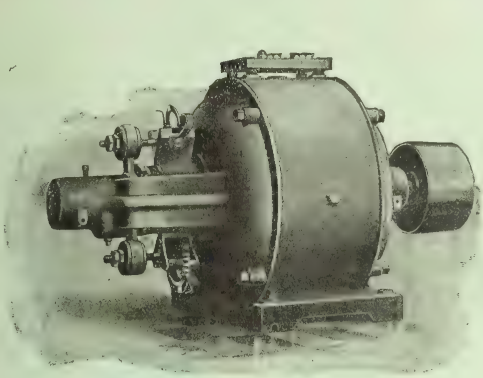

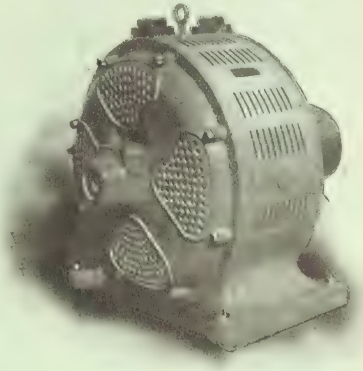

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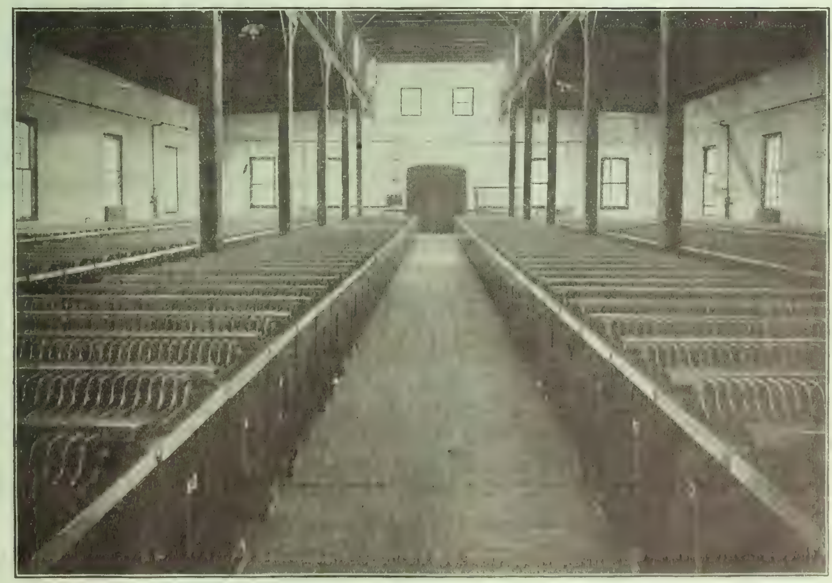

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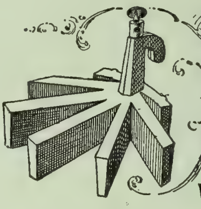

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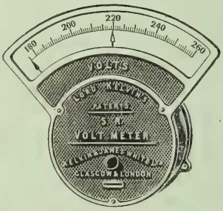

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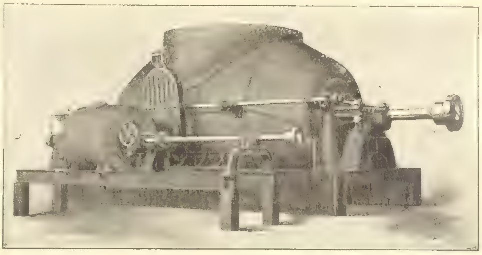

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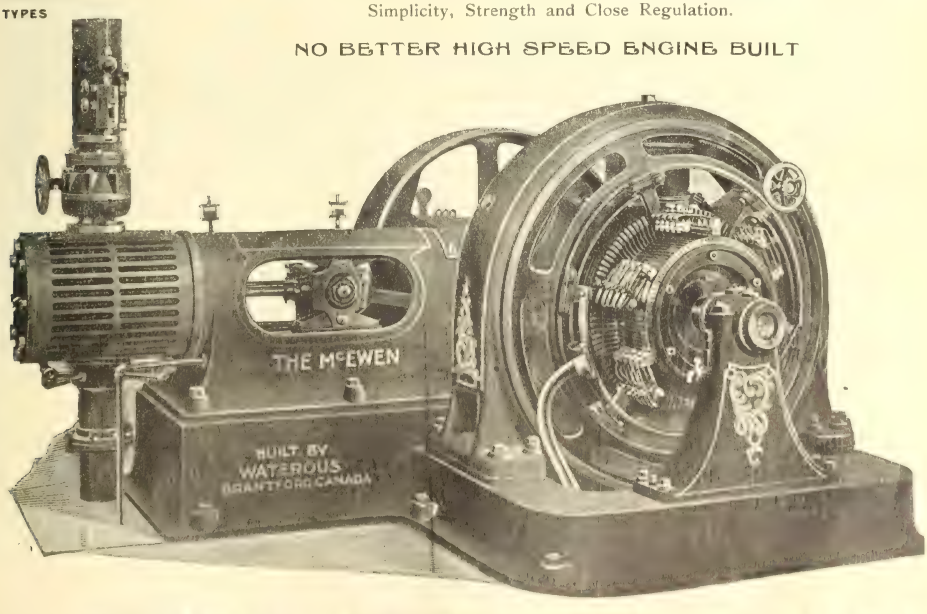

WATEROUS, BRANTFORD, CANADA

SPARKS.

Additional electrical apparatus is being installed in the C.P.R. power house at Fort William, Ont.

The capital stock of the Pembroke Electric Light Company, Pembroke, Ont., has been increased to $150,000.

Mr. Dickson, of the Kootenay Electric Supply & Construction Company, Nelson, B.C., has been engaged recently at Golden installing an electric plant there.

The Welland County Lime Works Company, of Port Colborne, Ont., are building a power house, in which they will install an electric light plant and gas engines.

The Kerr Vegetable Evaporating Company are installing an electric light plant at Canning, N. S. It is proposed to transmit power to Sheffield's Mills and Kingsport.

About $125,000 worth of improvements are contemplated at the Hall Mines Smelter at Nelson, B.C. These improvements will include the addition of motors sufficient to increase the power from 250 to 500 h.p.

The Canadian Oil & Waste Saving Machine Company, Limited, has been incorporated at Brockville, Ont., with a capital of $50,000, to manufacture machines for separating and reclaiming oil waste and other substances. The directors are Messrs. J. H. Botsford, W. S. Buell and F. E. Clayes.

The ratepayers of Exeter, Ont., having voted down the proposition to install a municipal electric light plant, it is probable that a new contract will be given to the Exeter Electric Light Company. In return for a ten or fifteen year franchise, the company would agree to enlarge and improve their plant.

The Shipton Electric Company, of Vancouver, B.C., have moved from their old quarters on Alexander street to Abbott street, where they are continuing the business of repairing, selling and installing electrical apparatus of all kinds. Messrs. Shipton are the local agent for T. & H. induction and direct current motors.

Although it is only a short time since the Kamloops, B.C., electric lighting system was installed, the capacity of the generators is already being taxed to almost their full capacity and in all probability they will need another generator by next year. Over 700 new lights have been added during the past year and the demand for this season has not yet stopped.

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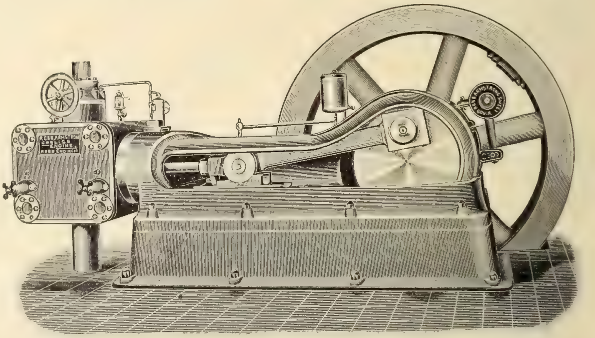

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SPARKS.

The Columbia River Lumber Company, of Golden, B.C., have recently purchased a 75 kilowatt generator from Allis-Chalmers-Bullock. This generator will supply current for lighting their saw mill at Golden.

A 10 kilowatt direct connected Allis-Chalmers-Bullock generator, 5500 volt for lighting purposes, is being installed in the new C.P.R. Kootenay Lake steamer now in course of construction at Nelson, B.C.

Mr. James Mowbray, late superintendent of the Clergue mines at Sault St. Marie, Ont., is the inventor of a new snow-plough. It is known as a lift plow, and is capable of clearing a track covered six feet deep with snow at the rate of 40 miles an hour. It lifts the snow and distributes it.

Allis-Chalmers-Bullock, Limited, have just supplied a 400 h.p. motor to the White Bear Mine at Rossland for driving the air compressor there. They have also supplied a 5 drill air compressor plant to the Dominion Copper Company, of Phoenix, for the Rawhide Mine. This compressor will be driven by a 75 h.p. Allis-Chalmers-Bullock motor.

The Pittsburgh Transformer Company, Pittsburgh, Pa., report that amongst the users of their standard thawing outfits of last winter, L. A. Audet, of Magog, Que., and the superintendent of the waterworks department, Sherbrooke, Que., wrote the company stating the results secured by the use of this method of thawing frozen pipes. A number of other Canadian towns used these outfits, among these being the Stanstead Electric Company, Stanstead, P.Q., town of Farnham, P.Q., Water & Light Department, Moncton, N.B., and Richelieu Wollen Mills, Chambly Canton, P.Q. The company states that they are prepared for a much larger business with their 1906 outfit, as it was evident from the enquiries received late in the season last year that a considerable number of prospective customers delayed purchasing until too late and postponed buying until the following season.

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Where Electric Power is available it is often desirable to use Electric Hoists instead of Hoisting Engines.

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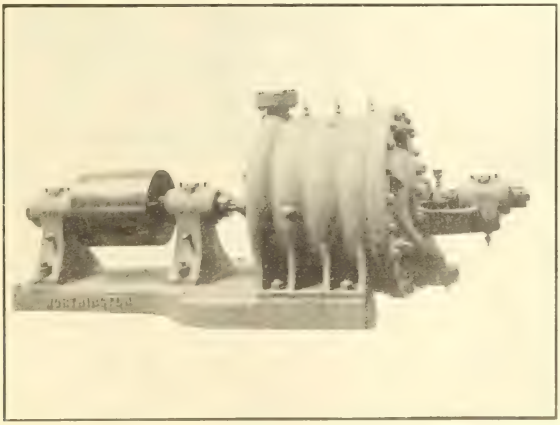

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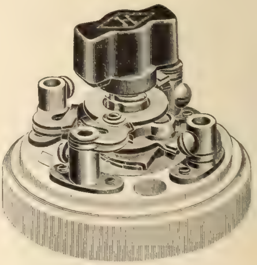

SPARKS.

The Papineauville Electric Company have taken injunction proceedings against George S. Hay to restrain him from using a dam on the Nation river.

The two daily newspapers of Victoria, B. C., have each been investing in motors. The Colonist Printing and Publishing Company have purchased a 30 h.p., 3 phase, 220 volt induction motor and the Times Company a 20 h.p. motor.

The Hinton Electric Company, of Vancouver, have supplied two double-drum electrically direct driven hoists complete with 15 h. p. motors and series parallel controllers for hoisting purposes for the work on the new post office in that city.

The city of Victoria has purchased from the Hinton Electric Company one 150 k. w., 2200 volt, 2 phase A. C. generator complete with exciter and switchboard, also one hundred and fifty 7.5 ampere long burning enclosed series alternating arc lamps; five 50-light regulating transformers; five 50-light arc lighting panels, with instruments and oil switches complete.

The use of private electric lighting systems in saw mill plants in British Columbia is rapidly growing. During the past few weeks the Hinton Electric Company have supplied the following mills with electric lighting apparatus: The Ladysmith Lumber Company, Ladysmith, one 6-k.w. 110 volt D.C. lighting generator; British Lion Milling Company, Hazelmere, a complete lighting plant including 5 k. w. dynamo, and 6×6 automatic vertical engine for driving same; and the Vancouver Sash and Door Company, one 6 k.w. 110 volt lighting dynamo. The Brunette Saw Mills, of New Westminster, have purchased an electric crane complete, to be used for loading heavy timbers.

The town of Arrowhead, B. C., will shortly enjoy electric lighting facilities, an arrangement having recently been consumated between the Big Bend Lumber Company and a majority of the inhabitants of the town whereby the company will supply electricity from their plant. Mr. J. E. Spurling, of the Lawrence Hardware Company, Revelstoke, has been engaged for the past few weeks wiring the various buildings and directing the connections with the power house. All the business places and practically all the residences of any size are being wired. The wires leading from the electric light station are two circuit connected parallel for full load and are arranged so that the voltage in the town can be regulated from the switchboard. A 45 k.w., 110 volt direct current generator is capable of supplying sufficient light enough for the whole town, besides the amount necessary for lighting of the mill.

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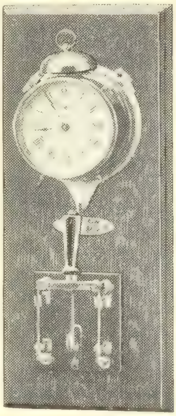
- Automatic Time Switch -



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TRADE NOTES.

The Robertson Machinery Company, Limited, has recently been organized at Welland, Ont., to manufacture hoisting machinery and contractors' plant. The officers of the company are Alexander Robertson, president; G. W. Sutherland, vice-president; C. H. Hanson, secretary-treasurer.

The Duncan Electrical Company, Limited, recently incorporated in Montreal, have opened up a manufacturing business and will make electrical supplies principally from their own patents. It is the intention to build lamp guards and all lines and finishes of sockets, rosettes and receptacles, also stamped and sheet metal specialties. They are at present offering to the trade a sheet metal lamp guard manufactured under their own patents.

The confidence of Cobalt miners in the future of that district is shown by the scale on which they are investing in mining machinery. M. J. O'Brien & Company, whose mine is on the edge of Cobalt Lake, recently bought from Allis-Chalmers-Bullock, Limited, a complete power house equipment, including boilers, hoisting engines, 7-drill compressor plant, boiler feed pump, large general supply pump, and high speed engine and generator for electric lighting. The compressor is of the Ingersoll-Sergeant self-contained type and the whole machine is mounted on a continuous box girder frame specially designed for heavy mining work.

The United Gas, Electric Light & Fuel Company, Sandy Hill, N. Y., report that the first three weeks they had their Pittsburgh thawing outfit in operation they took in seven and one-half times the cost of the outfit, and numerous other plants have reported excellent receipts from this source. It is evident that under favorable conditions a wide-awake station manager should not only pay for his outfit completely in the course of a week or ten days operation, but should derive a revenue of several hundred dollars a week as long as the cold weather continued. The Pittsburgh Company wishes to urge those interested to make enquiry regarding price and secure promise of delivery early in the season, for if this is delayed the factory's capacity may be overtaxed.

SPARKS.

The City Council of Brantford, Ont., have given a new contract for street lighting to the Brantford Electric & Operating Company.

The Hamilton Cataract Power, Light & Traction Company will shortly have the extensions to their power plant completed. They have installed new turbines and made many other improvements.

The City Council of Chatham, Ont., have rejected the proposition made by the Chatham Gas Company to furnish electric lighting, and accordingly will take steps to improve the municipal plant. A new dynamo will be purchased.

The City Council of Halifax, N.S., have appointed a committee to secure information regarding the cost of electric lighting. The contract with the Halifax Electric Tramway Company expires on July 1st, 1906.

The Canadian General Electric Company will supply the meters required during the coming year by the Corporation of Orillia, Ont. Mr. J. B. McRae, C.E., of Ottawa, has been instructed by the Council to prepare plans for a new cement dam at the power house at Ragged Rappids, to be built next spring.

The British Columbia Electric Railway Company recently distributed among their employees the sum of $17,000, each employee receiving $40. This sum represents the annual dividend distribution. This company enjoy the distinction of being the only street railway company that has a profit-sharing system and divides a percentage of the dividends among the employees.

The Queen Victoria Niagara Falls Park Commissioners recently considered the application of the International Railway Company, operating the Niagara Falls Park & River Railway, for permission to use some of the electric energy generated at their power house in the park for traction purposes on the American side. The commissioners decided to deny the application on the ground that such a permit might engender disputes between the city and the railway company, both of which take water from a common intake.

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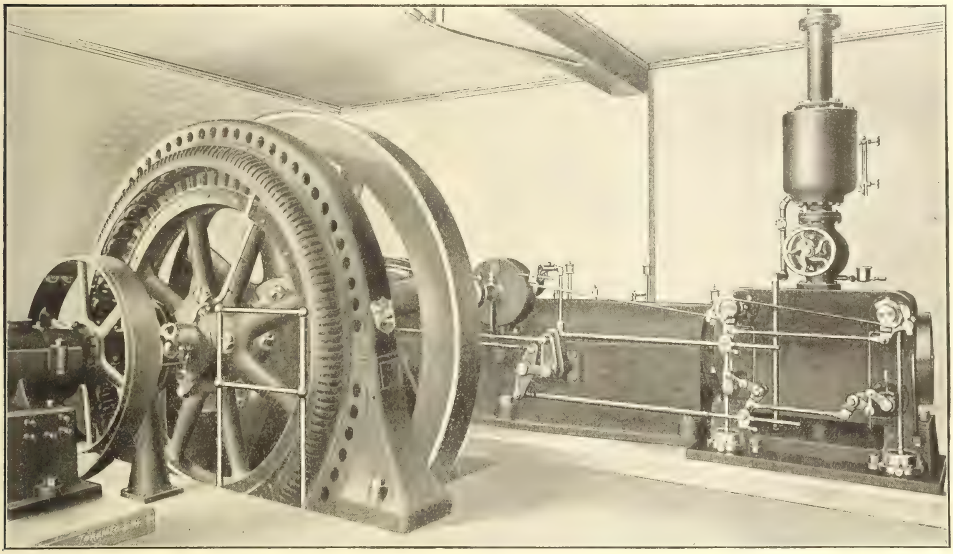

A view of the East Toronto Lighting Plant showing one of our 150 k.w. Alternating Current Generators driven by a Goldie & McCulloch Corliss Engine.

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Works: MONTREAL

BRANCH OFFICES: HALIFAX, TORONTO, WINNIPEG, NELSON, VANCOUVER

SPARKS.

The London Electric Company, London, Ont., are building a new boiler house.

Messrs. Bowen & Company are installing electric lighting at Burritt's Rapids, Ont.

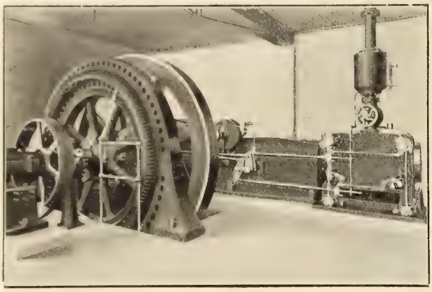
The ratepayers of Ladysmith, B.C., on October 7th voted down the proposition for the city to install and operate an electric light plant.

A public meeting will likely be called by the Council of North Toronto, Ont., to discuss the advisability of installing a new electric light plant.

The St. Johns Electric Light Company, St. Johns, Que., are now running on power supplied from Chambly. The company will retain their steam plant as a reserve.

The Council of Smith's Falls, Ont., have refused an offer of $56.25 per light per year for 57 arc lights for the streets from the Smith's Falls Electric Light Company.

The civic lighting plant at Calgary, N.W.T., which has been installed at a cost of $60,000, has been put into operation. The plant is capable of supplying, in addition to the street arc lamps, 6,000 incandescent lamps, but it is understood that less than 40 applications for domestic services have thus far been secured.



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We make a specialty of engines for driving direct connected alternators which are required to run in parallel. The regulation obtained by our governor is exceptional.

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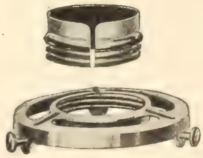

This Holder is made in two parts, consisting of a Slit Screw Collar and Holder.

It may be attached to any standard socket without the use of tools, and is as firmly held in place as if it were a part of the shell itself, holding the shade or globe in a direct or true center, and its rigidity prevents (by ill use or otherwise) the shade from being sprung from a correct position.

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NEW SWITCHES.

The well known supply house of John Forman, Montreal, has recently distributed to the trade an attractive pamphlet illustrating the "Noscru" key arm switch and the "Sarco" pendant switch, both of which articles have recently been placed on the market. These switches can be applied to a great many uses.

"SARCO" PENDANT SWITCH.

The "Noscru" switch has been designed to take the place of the unsightly key socket on an electric light fixture and is tested to carry three amperes. The pendant switch is very neat in appearance and is especially adapted for fixture work. It will not burn out on ten amperes and consequently it can be used on all arc lamps. It is impossible for it to get grounded or short circuited, and, having an interchangeable reduction bushing, can be used for reinforced portable new code lamp cord as well as for the regular cord. Mr. Forman is carrying a stock of the pendant switches, for which he is receiving large orders.

ELECTRICAL INSPECTION BUREAU.

Among the firms registered in Montreal during the past month we notice the Electrical Inspection Bureau and Testing Laboratory, the new firm being an outcome of the Electrical Inspection Bureau operated for the past ten years by Mr. W. J. Plews in connection with his consulting work. The new concern will be operated jointly by Mr. W. J. Plews and Mr. C. L. Trimingham, of Montreal. Mr. Trimingham is a graduate of McGill University, being late of the engineering staff, and has also had considerable experience in the practical field.

The intention of the new firm is to continue the supervision and inspection of general electrical installations and to issue certificates on same; in addition it is proposed to undertake on a large scale the testing of all kinds of electrical apparatus and fittings and a general consulting engineering business, and for which we understand a very complete and flexible equipment has been installed. Such a laboratory must necessarily fill a long felt want, as it is the only concern of this kind in Montreal, if not in Canada, where not only electrical manufacturers and supply men, but the general public, can have tests made at any time, and at a charge which would be small in comparison with the cost of equipping and maintaining a laboratory of their own for such intermittent work.

Especially in these days when one hears so much of disputes between light and power companies and their customers, it is both useful and comforting to the general public to know that it is possible to have the services of a competent and impartial concern, to whom all disputes can be submitted.

Mr. R. S. Kelsch, consulting engineer, Montreal, will purchase for the Ogilvie Flour Mills Company, for operating their large mills, elevators, etc., at Winnipeg and Fort William, the following electric apparatus: One 900 k.w. 2,200 v. synchronous motor; one 800 k.w. 2,200 v. induction motor; one 250 k.w. 2,200 v. induction motor; three 100 h.p. 2,200 v. induction motors; three 50 h.p. induction motors; two motor-driven turbine fire pumps; two motor-driven circulating pumps, and eighteen small induction motors, switchboards, transformers, etc. The mills at Winnipeg will be operated by power received from the Winnipeg General Light and Power Company. This power is expected to be ready for service about March 1st, 1906. The mills and elevator at Fort William will be operated from the Kaministiquia Power Company's new power development, which is expected to be ready about June 1st, 1906.

Thawing

Frozen Pipes.

Almost any old rig will thaw out pipes but there is only one way to do it rapidly and safely—use the Pittsburgh 1906 Thawer. With plenty of current, plenty of voltage, and all under perfect control, this is the best outfit ever made for this purpose. The preliminary book was mailed November fourth; if you did not get your copy, write for another and ask for (confidential) book of operating instructions and quotation on

The 1906 Thawer

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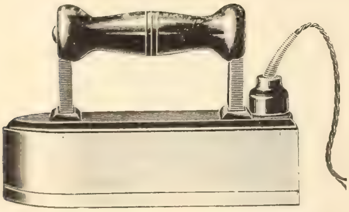

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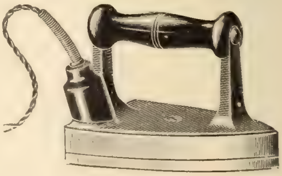
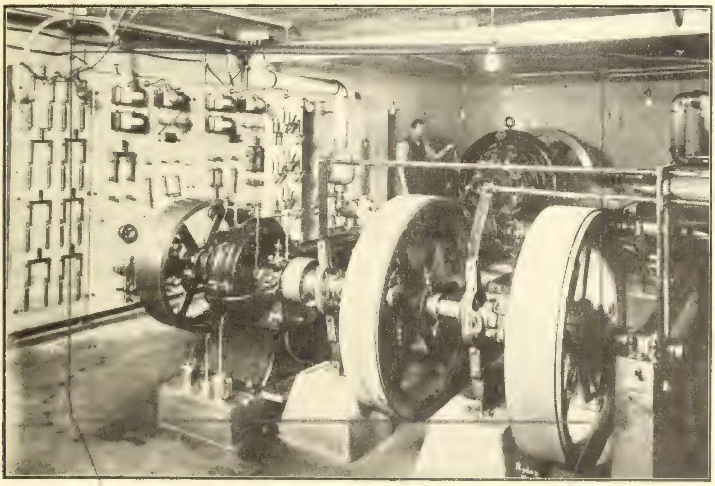


CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

Vol. XV. NOVEMBER, 1905 No. 11.

Power and Lighting Plant of the "Free Press" Building, Winnipeg

The new building of the Winnipeg Free Press is the largest in the Dominion of Canada devoted to newspaper publication. Security, convenience and beauty are the three considerations paramount in its construction. The massive pressed brick and stone exterior, strong as it appears, is but an outer shell, the building being structurally a steel cage, its columns and girders being completely enclosed in brick, terra cotta or other fire-resisting material. The floors throughout are of concrete, strengthened and braced by heavy steel netting buried in the material.



The "Free Press" Plant View of Engine Room, Showing 20 H. P. Engine, Shafting and Clutch Pulleys, also 80 H. P. Peerless Engine Direct Connected to 50 K. W. Bullock Generator, and Four-Panel Switchboard.

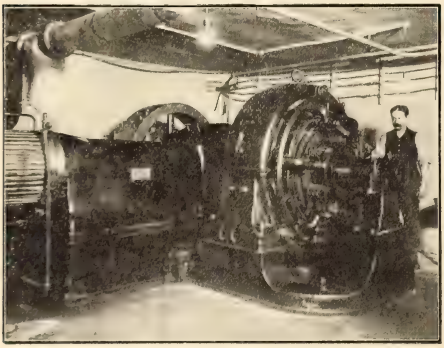
The power and lighting plant of the "Free Press" building consists of three units, as follows: One 120 h. p. Peerless engine, direct connected to a 75 k. w. Bullock generator supplying current for power purposes at 500 volts; one 80 h.p. Peerless engine, direct connected to a 50 k. w. Bullock generator supplying current for lighting circuits at 110 volts, and one 20 h.p. engine driving two belted machines, one of which generates current at a potential of 500 volts, the other at 110 volts. These small generators (14 k. w.) are driven by clutch pulleys mounted on the engine shaft and can be operated independently or together, as desired.

The "Free Press" publishing, as it does, both a morning and an evening edition, some part of the plant is in operation every hour of the twenty-four. Through the day the current required for lighting purposes is small and at certain hours of the night the power lines are also carrying a comparatively light load. This small unit was installed to relieve the large engines and generators of their light duties. The steam generating plant comprises three tubular boilers each of 100 h. p.

It may be here stated that the individual motor system obtains in every department where electrical power is used. There are in all 33 motors, varying in capacity from ¼ h. p. driving each linotype machine, to 35 h. p. driving the Hoe Quad press. This large machine is operated by the Kohler system of speed control, a brief description of which may be of some interest. In this system two motors are used, one of 5 h. p. for starting the press and running at the slow speeds, the other of 35 h. p. for the higher speeds. A number of push button stations (8 in this particular instance) are attached to the frame of the press and so placed that a station will be within easy reach of the pressman at all times. Each of these stations contains three push buttons as well as a safety switch.

The switchboard, which is of blue Virginia marble and upon which is mounted the various switches and devices for controlling and regulating the speed of the motors, is placed conveniently near the press. In starting, the attendant pushes the button marked "on". This closes the circuit in the coil located immediately back of the crosshead and releases the mechanism which supports it at its upper position. As the crosshead descends, the switch of the starting motor is automatically closed and the press starts. At each push of the button the crosshead descends a certain distance, the motor responding with an increase of speed. At the point where the small motor attains its highest speed the switch of the large motor automatically closes and the starting motor is relieved of the load. As the crosshead still further descends in response to the push of the button, the large motor gradually increases in speed until the small motor slows down until a point is reached about half way in the travel of the crosshead, when the small motor stops. As the crosshead nears the bottom of its stroke the resistance in the armature circuit is entirely cut out and the motor is running at its normal speed. Hurry up speeds are gained by allowing the crosshead to descend further, when it introduces resistance in the shunt field. The off button is used for reducing the speed or gradually slowing down preparatory to stopping. By pushing this button a circuit is established in the large coil which controls the crosshead and it ascends, restoring the resistance in the armature circuit and thus regulating the speed of the motor.

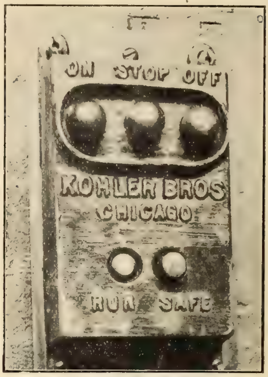
The stop button, as the name implies, is used when, through the breaking of the paper or from any other cause, it is necessary to stop the press at once. Pushing this button opens the circuit in the coil of the main switch, allowing it to drop, at the same time completing a circuit through a resistance coil in series with the armature, which acts as a dynamic brake, bringing the machine speedily to rest.



THE "FREE PRESS" PLANT—120 H. P. LEONARD PEERLESS ENGINE DIRECT CONNECTED TO 75 K. W. BULLOCK GENERATOR.

The function of the safety switch in connection with the push button stations, is to provide every man working about the press with the means of protecting himself against accident, through the machine being inadvertently started while he is in a position in which he might be caught by the moving cylinders. The wiring of the station is so arranged that, when any of the safety switches are thrown, the circuit of the "on" button in each station is open and it is impossible to start the press.

The practical operation of the system is very satisfactory, affording as it does every facility for the complete control of the machine, and that too, at a number of different points, the pushing of a button being all that is necessary to effect any desired change in the running of the press.



PUSH BUTTON CONTROLLING APPARATUS FOR HOE QUAD PRESS.

The Webster system of heating is used throughout the building.

Careful provision is made to guard against a breakdown of the power and lighting plant. One huge boiler is always in reserve. A duplicate power and lighting plant is ready to start up at a moment's notice, and even in the event—a remote one—of the duplicate plant breaking down, a third is available in an instant through a conduit connection with the power and lighting plant of the Winnipeg Electric Street Railway Company.

The mechanical superintendent of the whole plant is Mr. R. J. Buchanan, who is well qualified to take charge of this splendid plant—a credit alike to the owners and to Western Canada.

INCANDESCENT LAMPS IN COAL MINES.

It is well known that the ordinary incandescent lamp radiates an appreciable amount of heat. This is a fact to be borne in mind always by window dressers and others who are tempted to place the lamp in juxtaposition to combustible material. There is, according to the London Times, another possible danger, and that is in coal mines. Experiments by M. F. Holliday of the Littleburn Colliery have shown, it is said, that a 100-volt 16-candlepower lamp is capable of causing smoke to rise within three minutes when embedded in coal dust, or may cause flame within 25 minutes when laid on the top of coal dust. Again, the investigations recently conducted by H. Hall, one of the British inspectors of coal and metalliferous mines, proved, it is asserted, that when a 16-candlepower lamp was placed upon and partly covered by coal dust an explosion of the bulb occurred at a temperature of 450° F. within four minutes. These experiments further showed that when the heat had increased to a certain point spontaneous combustion began to operate and the temperature continued to rise until the coal caught fire, although the lamp had been removed for some time.

ECONOMY OF ARC LAMPS.

The Elektrotechnische Zeitschrift publishes a long discussion of the economy of various types of arc lamps with special reference to the number connected in series. It is pointed out that there are a great many different factors besides energy consumption which must be taken into account in determining the economy of a given type of lamp, and the article contains a number of tables and diagrams comparing the economy of the different lamps with respect to energy consumption alone. The following table gives the watts consumed in order to obtain 2,000 Hefner candles with ordinary carbons and with flame arc lamps;

ORDINARY CARBONS.

110 volts,	2 lamps in series,	1250 watts.
110 volts,	3 lamps in series,	1060 watts.
220 volts,	4 lamps in series,	1575 watts.
220 volts,	5 lamps in series,	1350 watts.
220 volts,	6 lamps in series,	1350 watts.

FLAME ARC LAMPS.

110 volts,	2 lamps in series,	800 watts.
220 volts,	4 lamps in series,	950 watts.
220 volts,	5 lamps in series,	1000 watts.

These results are of interest when lighting installations are planned for towns of medium size. Many customers, for instance, can use two or three arc lamps, but no more. At 220 volts it is necessary to use a larger number of lamps, whereby the cost of installation is increased. Moreover, with the same consumption of energy less light is obtained. Further, it will be noticed that the connection of six lamps in series is not superior to five lamps. It may be different, however, if in a larger installation a certain number of lamps is prescribed. If sixty lamps are required, it will be possible to get more light by connecting six lamps in series than five in series. For instance, 13.2 kilowatts give in such a case 20,000 Hefner candles for ten circuits each containing six lamps in series and each consuming 1.32 kilowatts. The same energy gives 16,800 Hefner candles in twelve circuits each containing five lamps in series and each consuming 1.1 kilowatts. With enclosed arc lamps the energy consumption is almost always higher, enclosed lamps being superior only for small intensities of light. The whole situation is, however, changed if the consumption of carbons, cost of attendance, interest and depreciation are considered. It is shown that for small intensities of light the enclosed lamp is quite economical. The connection of six lamps in series at 220 volts is no more economical than a connection of five. For small light intensities and short hours of burning, four lamps in series may be more economical than six lamps. With the flame arc, four lamps in series at 220 volts are not less economical than five lamps in series. The flame arc lamp is to be taken into consideration only for great light intensities, such as 1000 Hefner candles at 110 volts and 2000 Hefner candles at 220 volts, but for all practical conditions the flame arc is more economical than other types of lamps. The superiority of three lamps in series over two lamps in series appears only at longer hours of burning or with greater light intensity. In every respect 220 volts appears to be less economical than 110 volts for arc lamp installations. There is no difference between alternating and direct current with respect to flame arcs. Ordinarily arc lamps, however, when operated with alternating current, three in series, at 110 volts, consume about 60 to 70 per cent. more energy for the same light than with direct current, three lamps in series, and 40 to 50 per cent. more enery than with direct current, two lamps in series.

OPPORTUNITIES IN THE ELECTRICAL BUSINESS.

The prospects of large financial success of the engineering graduate are the same as those of the graduate of the college of medicine or of law. The great prizes are only for the few. A comfortable maintenance is for the majority, and the failures are no greater in number than in the other professions.

An interesting exhibit of what 100 picked men between the ages of 27 and 43 in the electrical engineering business have done was given not long ago in a paper by George A. Damon, of the Arnold Company, of Chicago, entitled "The Opportunities in the Electrical Business," read before the electrical section of the Western Society of Engineers. Mr. Damon sent a letter of enquiry to 100 of the leading men in Chicago engaged in the various branches of the electrical industry.

The summary of the results of his enquiry was as follows: Young men control the business. The inquiry was therefore confined to men between the ages of 27 and 43 on the theory that the older men are the product of a set of conditions that have passed away, while the youngest men are, as a rule, still engaged in a period of preparation. The 100 men are divided into groups as follows:

	No. of men	Average Age	Average Income
Salesmen	7	33	$2,400
Sales managers	11	36	3,400
Business men	10	36	4,800
Sales engineers	8	35	2,350
Electrical engineers	16	33	2,800
Constructing engineers	6	33	2,850
Electrical experts	8	33	3,200
Operating engineers	3	32	2,250
Operating managers and superintendents	10	34	3,550
Professors and editors	8	34	2,500
Patent attorneys	4	32	4,000
Consulting engineers	9	40	6,400

Total number of men, 100. General averages: age, 33½ years; income, $3,440.

Classified in reference to incomes, the record is as follows:

	Men
Income over $10,000 per year	5
Income between $5,000 and $10,000	9
Income between $2,400 and $5,000	66
Income below $2,400	20
Total	100

Seventy-five per cent. of these men are college graduates. The average age of twenty men who are succeeding without a college education is 36 years, and their success measured by a monetary standard shows an income of $3,670 a year. The average age of sixteen graduates of one university is also 36. Their average income is $4,940, which shows a balance of $1,270 a year in favor of the college education. Mr. Damon says that there are in Chicago at least 100 men whose incomes will average about the same as the first 100 selected. An effort was made to make the list representative, and the men were selected on account of their positions without reference to their incomes.

THE MULTIPLE OPERATION OF TRANSFORMERS

By R. T. MacKeen.

It is universally considered good engineering practice to operate transformer units suitably selected, in parallel. Without this means of increasing the capacity of a generating plant or distributing system, the expansion of the electrical industry would meet with serious impediment. While the advantages of the multiple operation of transformers are very generally appreciated by operating engineers, yet the results of the indiscriminate grouping of transformers in this manner are not so fully realized. It is the purpose of this discussion to present to the reader the principles involved in the multiple operation of transformers and thus endeavor to provide means whereby indiscriminate grouping of transformers can be guarded against and instead a selection and arrangement adopted to accomplish the best results; as will be shown later, the grouping together in multiple of transformers too frequently results in the overloading of some of the units. This in practice is not usually considered, the main object being to get upon the circuit sufficient kilowatt capacity to take care of the maximum demand of the system.

It is often an occasion of some surprise when one or more transformers, part of a system operated in parallel, burn out, without any apparent reason. The capacity of the group of transformers is ample for the maximum demand; it therefore cannot be due to overload, it must be the result of defective workmanship in the transformers, and thus the manufacturer has to bear the brunt of the results of the lack of knowledge or judgment on the part of the operator.

It is obvious that the successful solution of the problem is obtained if we can determine and provide the conditions under which each transformer on the circuit will carry a part of the load proportional to its rated kilowatt capacity output.

Let Fig. 1 represent an arrangement of transformers operating in multiple, with interconnecting leads of negligible ohmic resistance and reactance, and supplying a common load. Also assume the transformers are designed for the same periodicity and primary and secondary voltages; it being obvious that the two latter conditions are absolutely essential for parallel operation.

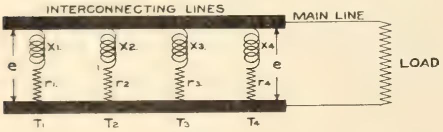
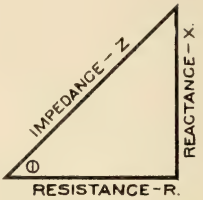


FIG. 1.

Let the transformers have resistances $r_1 - r_2 - r_3 - r$ - reactances $x_1 - x_2 - x_3 - x_4$ -, thus having impedances $z_1 - z_2 - z_3 - z_4$ -, it being remembered that the impedance is the square root of the sums of the squares of the resistance and the reactance, and is analagous or equivalent to the ohmic resistance in direct current diction.

The equivalent resistance and reactance of a transformer (i.e., the value representing both primary and secondary resistance and reactance in ohms) bear the same phase relation to each other as the base and perpendicular of a right-angled triangle, the hypotenuse representing the impedance as in Fig. 2.



Φ= PHASE ANGLE.

FIG. 2.

From this relation it is obvious that it is quite possible to have transformers with the same impedance yet widely different values of resistance aud reactance. This suggests a point that should be considered, namely, the difference in phase between the impedance voltages and hence the currents of two transformers having identically the same impedance ohms and voltages (impedance volts being the product of impedance ohms and amperes.) As seen, this is quite possible by varying the lengths of r and x, as shown in Fig. 3. This difference in phase doubtless affects the distribution of load to some extent, yet the phase difference in practice is so small as to practically be negligible in its results, and in fact it is quite safe to neglect this difference in phase and assume that all commercial transformers may have the same ratio of resistance to reactance, i.e., the same phase of impedance voltage and hence same power factor, yet have widely differing impedances.

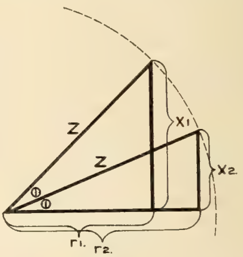


FIG. 3.

Our rules for load divisions are as follows:

First: "When two or more transformers of the same voltage and periodicity are operated in multiple and have interconnecting leads of negligible resistance, as in fig. 1, the loads carried by each will be inversely proportional to their impedances or directly proportional to their reciprocals their admittances."

Second: "The load carried by each transformer will bear the same ratio to the total load as its admittance bears to the sum total admittances of all the transformers."

Just as impedance in alternating current diction is analagous to resistance in direct current diction, so admittance corresponds with conductance.

It is frequently thought that the distribution of load among transformers is proportional to their percent regulations. This would be the case if the regulation were directly proportional to the impedance, but such is not the case.

It is more usual to express the impedance of a transformer in volts rather than in ohms. The impedance volts are easily determined by short circuiting the secondary and applying a low potential to the primary until full load current is obtained in the secondary. Mannfacturers usually furnish this information on the test card accompanying their transformers. It varies in value from 2 per cent. to 5 per cent. of the primary voltage. As the impedance volts are directly proportional to the impedance ohms either value can be used in the rules given above, the only difference being that the impedance volts must be expressed in terms of unit load for all the transformers. This follows from the fact that the impedance volts is the product of impedance ohms and amperes, and varies with the load. For example, a 10 Kw. transformer has an impedance voltage of 4 per cent. at rated full load, or at unity load of $\frac{4}{10}$ or .4 per cent.

Now since admittance is the reciprocal of impedance or $\frac{1}{z}$ the admittance for the above transformer is $\frac{1}{.4}$ or 2.5, which we might call for simplicity the relative carrying power of the 10 Kw. transformer as compared with any other fransformers operated in multiple therewith.

Right here it should be noted that this value of admittance or relative carrying power can be obtained by simply dividing the kilowatt capacity of the transformer by its impedance voltage in percent. For example: The carrying power of the above transformer is $\frac{10 \text{ Kw.}}{4}$ or 2.5, the same result as before.

Now let us apply our rule to the determination of the division of load among five transformers of same voltage and periodicity connected in multiple, assuming as before that the impedance of the interconnecting line is negligible.

Size of Transformer.	Voltage.	Cycles.	Impedance Volts.
5	1040 2080-104 208	60	4.0
10	"	60	3.8
15	"	60	3.5
20	"	60	2.8
25	"	60	3.1

As the division of load is proportional to the relative admittance or carrying power of each transformer, let us first determine these factors.

Size of Transformer.	Impedance Volts.	Relative Admittance or Carrying Power $\frac{\text{Kw. Capacity}}{\text{Impedance Volts.}}$
5	4.0	1.25
10	3.8	2.63
15	3.5	4.29
20	2.8	7.15
25	3.1	8.06
75 Kw. Total		23.38 Total Admittance or relative carrying power.

Our rule states: "That the load carried by each transformer will bear the same ratio to the total load as its relative admittance or carrying power does to the total admittance or carrying power of all the transformers," hence the division of load will be determined as follows:

Size of Trans.	% Impedance volts at rated load	Rel. Admitt. or carrying Power.	Kw. Load Carried.		% of Total Load.	% of Rated Load.
5	4.0	1.25	$\frac{1.25 \times 75}{23.38}$	4.0	5.3	80
10	3.8	2.63	$\frac{2.63 \times 75}{23.38}$	8.45	11.20	84.5
15	3.6	4.29	$\frac{4.29 \times 75}{23.38}$	13.70	18.30	91.5
20	2.8	7.15	$\frac{7.15 \times 75}{23.38}$	= 22.95	30.60	114.8
25	3.1	8.06	$\frac{8.06 \times 75}{23.38}$	25.90	34.6	103.5
75		23.38		75.	100.0	

From this computation we find that theoretically, all the transformers will be carrying less than their rated load except the 20 k.w. and 25 k.w. sizes, which will be overloaded 14.8°/o and 3.5°/o respectively. This example serves to illustrate the method to be used in determining the approximate division of load for concrete cases.

It will be noted that the transformers with the higher admittances or relative carrying powers, and hence with the lesser impedances at unit load, assume the greater part of the total load.

So far we have neglected entirely the impedances of the interconnecting lines between the individual transformers and the load. These impedances enter into the problem in practice to the extent that when known they must be added to the individual impedances of the transformers, and from this an expression representing the admittances or carrying powers determined. The difficulty is, however, to determine the line impedances ; consequently, we can only approximate a division of load, assuming that the transformers are symmetrically disposed with regard to the load and each other so that the line impedances can be neglected.

Other factors also enter into the problem if we search for fine distinctions. For instance : The resistances and hence the impedances will vary with the temperatures of the transformers, which are not only functions of the design, but also dependent in great measure upon location and environment.

Before leaving our method of computation and discussing generalities it is interesting to note that when transformers of different sizes but of the same voltage, periodicity and per cent. impedance volts are operated in multiple, assuming negligible line impedance, the load will be divided among them in the ratio of the kilowatt capacity of each transformer to the total kilowatt capacity. For example : Assume a 10 Kw. transformer operating in multiple with two 20 Kw. transformers, all with the same per cent. impedance volts at full load. The 10 Kw. transformer will carry $\frac{10}{20 + 20 + 10}$ or 1/5 of the total load, and each of the 20 Kw. transformers will carry 2/5 of the total load. This simple rule follows from the fact that the per cent. impedance volts varies with the load, and at unit load the admittance or relative carrying powers would bear the same ratio to each other as the kilowatt capacities of the transformers.

While an approximate determination of the division of load among transformers as above is most useful, at the same time it is obviously of greater importance to know exactly the load division in practice, and this can only be determined by actual measurement.

An ingenious current transformer is now on the market which in conjunction with a suitable ammeter can be used for this purpose. The transformer, which has a hinged magnetic circuit, is merely clamped around the transformer lead, and connection made to an ammeter where the actual load is indicated on the instrument. By applying this test to all transformers banked in multiple an exact knowledge of the conditions is possible. When it is found that either due to difference in impedances of the transformers or the lines (the latter as a result of non-symmetrical arrangement), that an equal and proper division of load does not exist, means should be taken to correct these conditions. This can be done either by rearranging the transformers or lines or by inserting suitable reactance coils in the transformer secondaries. Such coils can be obtained from transformer manufacturers, or, as a temporary expedient a coil could be constructed by winding a few turns of insulated wire of the same cross section as the transformer lead about an iron core of sheet iron or iron wire; but a properly designed coil should be obtained from a reputable manufacturer for permanent service.

We may sum up our conclusions as follows:

1. For all pratical purposes the division of load among transformers is independent of their power factors, and depends only upon their impedances.

2. Transformers of the same or different design of the same size and impedance volts connected in multiple arranged symmetrically with respect to each other and the load, will divide the load with practical equality.

3. Transformers of the same or different design and of different sizes and the same percent inpedance volts at rated load, and arranged symmetrically with respect to each other and the load, will divide the loads in the ratio of their rated kilowatt capacity to the total kilowatt capacity.

4. Transformers of the same or different design and of different sizes and different impedance voltages at rated load, and arranged symmetrically with respect to each other and the load, will divide their loads in proportion to their rated capacity when provided with reactances which will compensate for the inequality of impedance voltages at rated load.

5. When the transformers are not arranged symmetrically with respect to each other and the load, the line impedances affect very largely the distribution of load, in possible cases even more than the difference in impedance voltages of the transformers.

6. In practice, it is almost impossible, owing to the continually changing load center and the complex arrangement of circuits to determine the line impedances, and provide for their symmetrical disposition, hence the only practical way of determining accurately the load division is by actual test at different periods of the day and principally under average and maximum load conditions. From such a test the circuit conditions are known accurately and proper provision can be made by a rearrangement of transformers, lines or load; or reactances provided which will enable a more equal division of load to be obtained.

The Canada Carb-Ox Company, Limited, Winnipeg, Man., has been incorporated, to manufacture smoke consuming apparatus.

MR. H. F. STRICKLAND.

Mr. H. F. Strickland, of Toronto, has received the appointment of chief electrical inspector for the Canadian Fire Underwriters' Association, succeeding Mr. A. Bruce Smith. Mr. Strickland has had an experience of eighteen years in electrical work, and, having served three years in the office of his father, Mr. W. R. Strickland, architect, possesses considerable knowledge of building construction, which will be a valuable adjunct in his new position.

Mr. Strickland was born at Peterboro, Ont., April 25th, 1870. After serving in his father's office, he spent several years in shop work and outside and inside electrical construction, being employed in the shops of the Western Electric Company and the old Ball Electric Light Company. He was for four years connected with the Toronto Incandescent Light Company as contract agent, and for two years was on the agency staff of the Canadian General Electric Company. For the past nine years he has been engaged in contracting work and engineering, one of the recent installations for which he was consulting engineer being the power and lighting plant of the Joseph Simpson Company, Toronto. This commission consisted of converting their entire power drives from steam to electric, the installation consisting of a 250 k. w. C.G.E. three-phase generator and twenty-three three-phase 550 volt motors, varying from three to thirty horse power, together with all wiring panels, transformers, etc. Another installation which he supervised was a complete power and light equipment for both the old and new works of the Goldie & McCulloch Company at Galt, Ont. He has also given expert testimony in several arbitrations between owners and municipalities.

Mr. H. F. Strickland,
Chief Electrical Inspector Canadian Fire Underwriters.

Mr. Strickland's business dealings have been characterized by straightforwardness, to which he may attribute in some degree at least his present appointment. He has served the Underwriters faithfully, while at all times aiming to secure justice for all parties. His record is such, therefore, that he may conscientiously ask the support and co-operation of the electrical industry in his new position. He has appointed Mr. Eugene Cutts, of the construction staff of the Toronto Electric Light Company, as his assistant.

Mr. Strickland is a well-known athlete and an ardent follower of the Natatorial art, having broken all long distance swimming records. Last year he made a ten-mile swim from Lakefield to Peterboro, Ont., in five hours and five minutes. He enjoys phenomenal health and has a magnificent constitution. In 1893 he married Miss Hall, second daughter of the late Frederic Hall, Deputy Sheriff of Peterboro, and niece of the present sheriff, Mr. James A. Hall.

UNLOADING ORE BY ELECTRIC MOTORS

One of the most interesting and notable examples of the remarkable advance in modern industrial appliances, is that to be found in the ore unloading equipment of the Great Lakes. The ore unloading facilities of the Great Lakes are far in advance of those in any other part of the world, and at not even the largest ocean ports is reached the marvelous speed of unloading and handling which has been obtained at modern lake docks.

A notable type of the modern equipment employed for the purpose, in fact the one holding the world's record for fast ore unloading, is the Hulett Automatic Ore Unloader, invented by Mr. Geo. H. Hulett, Third Vice-President of the Wellman-Seaver-Morgan Company, Cleveland, Ohio, who are sole builders of the machines.

The general view herewith shows the latest installation of these unloaders, namely, two electrically operated machines at the United States Steel Corporation's National Tube Company's docks, Lorain, Ohio.

An idea of the heavy service required of these machines may be gathered from the fact that they rapidly handle an enormous grab bucket, which, when open, has a spread of over 18 feet, and which automatically digs and conveys from the hatches of the boat ten gross tons of iron ore at a load. This bucket when open can by telescopic motion be extended still farther, so as to reach more than half-way from the centre of hatch to hatch. It is carried at the lower end of a vertical dependent leg suspended from a long pivoted walking beam, which is carried on a carriage or trolley which travels back and forth on the girders of the machine. The operator who controls all the motion of the bucket rides at the lower end of the leg directly above the bucket. By means of hoisting mechanism, the walking beam is made to oscillate up and down, carrying the bucket down into the hold of the boat and up again above the dock. The leg carrying the bucket is mounted on rotating trunnions in the walking beam so that it can rotate in a circle when operating in the hold of the vessel, permitting the bucket to reach out in all directions. It also travels lengthwise of the hatch, to the sides of the boat; consequently the operator is able to reach almost the entire cargo.

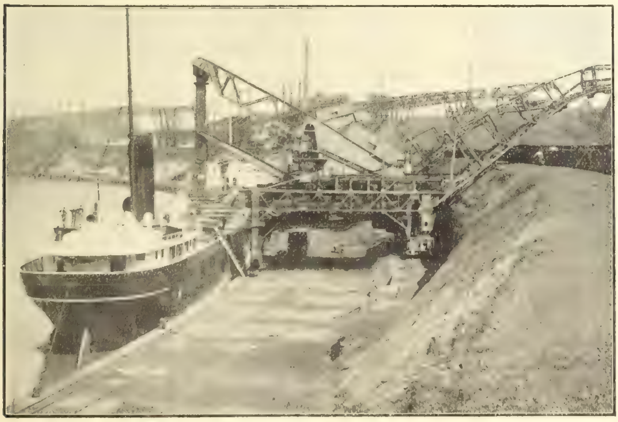


FIG. 1.—GENERAL VIEW OF HULETT UNLOADERS ON DOCKS OF UNITED STATES STEEL CORPORATION PLANT AT LORAIN, OHIO.

The travel of the trolley back and forth on the girders carries the walking beam with the bucket out over the boat and back over the dock. To reduce the trolley travel as much as possible, suitable hoppers for receiving the contents of the bucket are mounted between the girders at the front; these hoppers discharge into an auxiliary bucket car.

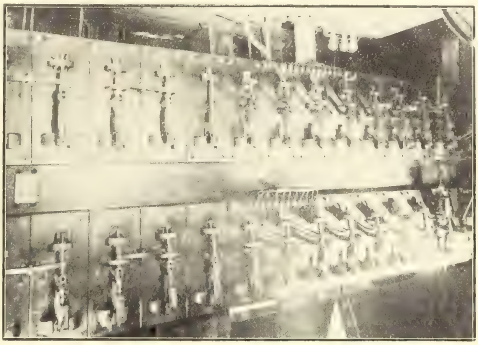


FIG. 2.—MAGNETIC CONTROLLERS FOR HOIST AND TROLLEY TRAVEL MOTIONS.

The Hulett unloaders at Lorain are provided with special cantilever extensions, designed particularly for delivering the ore on a high bank back of the machines. The bucket car travels on these cantilever extensions, automatically dumping the ore at any desired point and returning closed to its position under the hopper. The entire machine is mounted on moving trucks, enabling it to travel up and down the dock from hatch to hatch without moving the boat. The controlling devices for machines of this type are in all cases specially constructed to meet the conditions.

The controllers proper, for this unloader, consist of a number of magnetically operated clapper switches, which cut resistance in and out of the motor circuits. The switches are operated by solenoids placed on the back of the switch-panel. The main contact of each switch is a heavy laminated copper brush re-inforced with a yellow brass contact, the final break being taken between carbon contacts, and the arc is quickly ruptured by a powerful magnetic blow-out. The switches are controlled by small master switches located in the operators' cabs. As the solenoids of the switches require but few amperes, the wires connecting the master switch with the controller proper are of very small size.

Each motion of the unloaders is provided with a positively connected or geared automatic cut-out or emergency switch. The cut-outs on the hoist and bucket-car motions automatically slow down and stop these motions as the limits of travel are reached. They first operate to gradually introduce resistance and slow down the motor; then change connections to convert the motor into a generator, and apply a gradual dynamic breaking effect until the motion is nearly stopped, and finally apply band brakes.

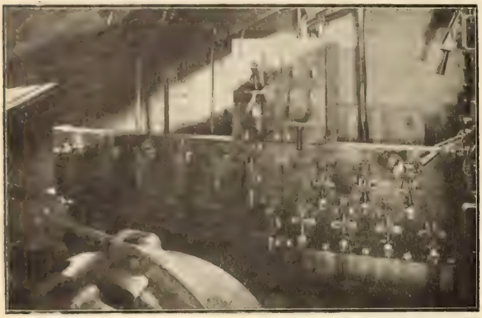


Fig. 3 Magnetic Controller for Operation of Grab Bucket.

The application of dynamic braking to the above mentioned motions is of particular advantage, as the energy of these heavy parts is absorbed and dissipated in the resistance, thus removing practically all wear from the solenoid band brakes. Under these conditions, the band brakes operate as holding brakes and are required to stop the motion only upon failure of current supply.

The bucket rotation and trolley motions are supplied with geared automatic slow-down and cut-out devices, which gradually insert the resistance and finally apply solenoid band brakes to stop the motion as the limits of travel are approached.

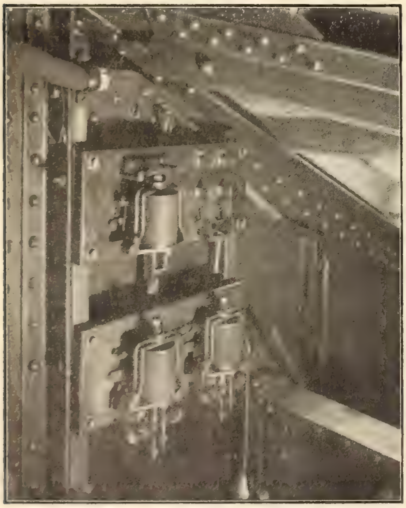


Fig. 4. Magnetic Controller for Bucket Rotation Motor.

While all of these automatic devices fully protect the machinery and motors against failure of current supply, confusion and faults of the operator, still they allow the operator full control of the motors at all times, with the exception that he is unable to pass a predetermined limit of travel of the motions.

The main controllers are located as near to their respective motors as possible, so that the heavy wires carrying large currents are made as short as possible. The master switches, or controllers, are small, thus allowing such an arrangement that all operating handles are brought within easy reach of the operator. They are very easily operated and do not fatigue the operator, thus allowing full output of the machines at all times irrespective of the physical condition of the operator.

The magnetic controllers, which control the movement of the bucket in and out of the boat and the raising and lowering of this bucket, are shown in fig. 2. To the left there are seen four pairs of two switches each interconnected by means of horizontal levers. These are the reversing switches and the function of the levers is to absolutely prevent the closing of both reversing switches at the same time. To the right are seen three switches interconnected by means of two levers. The function of these levers is to prevent the closing of the middle or dynamic braking switch when the motor is still connected to the line and operating as a motor. The levers are also used to hold open the switches at either side of the center switch when the motor is acting as a generator with the center switch closed.

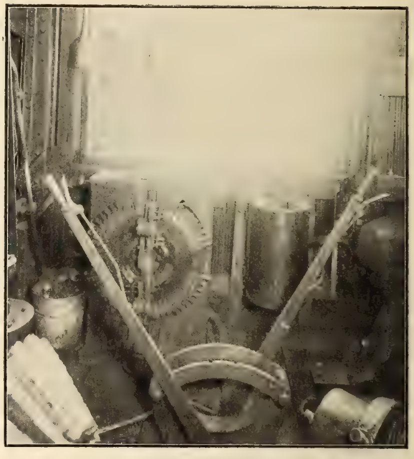


Fig. 5.—Bucket Car Operator Cabin.

Fig. 3 shows the magnetic switch controller for the operation of the grab or clam-shell bucket. The smaller switches, at the left, are the accelerating or resistance switches. These switches are so connected that the succeeding one depends for its closure upon the closure of the one preceeding. One terminal of the operating solenoid of each switch is connected to such a point on the resistance that the current, taken by the motor upon the closing of the preceeding switch, must fall to a certain predetermined value before the following switch can close. This means that the motor must come up to a speed corresponding to each accelerating switch before the following switch will close. This results in the smoothest possible acceleration in the shortest possible time consistent with safety to motor and driving mechanism, and makes acceleration of the motor entirely independent of the operator should he throw the master switch with extreme rapidity.

The result of this design is to cause the motor to approximate almost exactly the operation of a hydraulic or steam cylinder, that is, it will keep a predetermined pressure on the bucket jaws and will not exceed this pressure. The motor is generally stalled once during every closure of the bucket, and this occurs without injury to the motor, controller, or attached mechanism.

The master controller for operating the bucket rotation motor is shown in Fig. 4. This motion operates so easily that the controller is small and requires but few steps.

Fig. 7 shows the magnetic switch controller operating the bucket-car haulage motor. The ore is dumped from the bucket into a car which is pulled up the incline by a motor located in the machinery house underneath the trolley. The car is automatically dumped near the end of its travel by means of mechanical dogs.

Figs. 5 and 6, respectively, show the master controller and automatic slow-down and cut-out switch which control the motion of the car. The manually operated controller to the left of the master controller is used for the purpose of slowing the entire machine so that it may be brought parallel to the hatches of the boat; this dock being built on a large curve makes this motion necessary to secure the best operation. The main controller house is located on the trolley underneath the walking beam and is divided into two parts, one part containing the machinery and controllers, and the other the resistances.

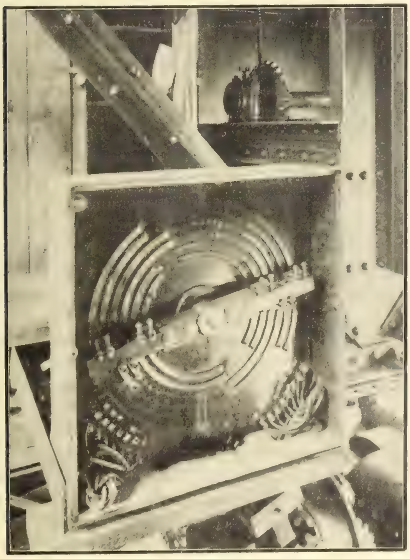


FIG. 6.--AUTOMATIC SLOW-DOWN AND CUT-OUT SWITCH FOR BUCKET CAR MOTOR.

This type of control was designed, developed and built by the Electric Controller & Supply Company, of Cleveland, Ohio, who also manufactured and supplied all magnetic cushion type solenoids for band brakes and all other electrical details.

TRANSMISSION LOSSES.

A measurement of the loss into the atmosphere and over insulations of the two-wire line of the Missouri River Power Company, whose lines run between Canyon Ferry and Butte, a distance of sixty-two and a half miles, gave results which show how difficult it is to make provision for all contingencies in high pressure practice. Some of the figures obtained will prove instructive and interesting, in that they show how a higher pressure in the line means a greater line loss in this peculiar way, and a lower pressure the contrary. For instance, with 40,000 volts in the line, the total line loss totalled up to 2,864 volts. Of this loss about 1,644 volts were due to the drop through the line resistance. The balance of 1,220 volts was simply a dead loss of pressure due to the voltage finding a path over the insulators and into the air. According to these particular figures a loss of 5 per cent. in line pressure occurs in this manner. Examining the figures further, as given by Mr. Percy H. Thomas, a pressure of 50,200 volts in the line with the weather wet, meant a loss of 8,120 volts in the line. This remarkable waste of energy itself is a loss of 2,595 volts due to line resistance, and a loss of 1,220 volts through the insulators into the air. With 53,500 volts the total line loss reached 8,892 volts, divided up as follows: 2,940 volts in the line as drop, and 5,950 over the insulators and into the air. With a a final line pressure in this particular test for data, of 61,400 volts, the total pressure loss reached 14,160 volts. This was divided up as 3,830 volts loss in the line through drop, and 10,330 volts loss over the insulators into the air. The fact thus brought to light is that the dissipation of energy through a loss of delivered potential is an important percentage of the total pressure generated or impressed upon the conductors. The 61,400 volts line pressure losing 14,160 volts through the combined effects of drop and leakage, mean more than a 20 per cent. loss in this manner. According to further estimates made, a 150-mile three-phase, 75,000 volt plant would lose about 90 kilowatts total. The loss in the 61,400-volt system of power transmission would average up about 140 watts per mile. On this basis the 62.5 mile run would constitute a loss equal to 135 times 140 watts, or a total of nearly nineteen kilowatts. The result of the continued and complete test seems to show that this radation or leakage of electricity into the air would not seriously affect the efficiency unless the pressure rose to the value of 80,000 volts.

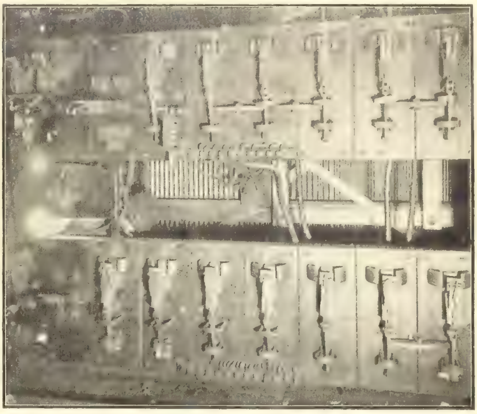


FIG. 7.—MAGNETIC CONTROLLER FOR BUCKET CAR MOTORS.

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Correspondence is invited upon all topics coming legitimately within the scope of this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

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The Lamp Question.

The "free lamp renewal" idea has been thoroughly discussed at some of the recent meetings of Electric Light Associations held in the United States, and as a general thing it may be stated that the large central station has adopted this policy, while the smaller has not and still continues to question its value. While we have devoted much space in these columns to this very subject, the problem to our minds is of such vital importance that we feel justified in bringing it to the attention of our readers once again. As above stated, many of the smaller stations have not adopted the idea, and still doubt the wisdom of the move, but as a matter of fact, they have nothing tangible to show that the idea is wrong. On the other hand, the large stations, who no doubt watch their profits better and with more care, claim to receive annually many times the amount invested in lamps, and when such a statement is made, it is certainly worthy of some consideration. Then here is another feature of the case. Has any company ever adopted the free lamp renewal idea, and then dropped it? All the evidence, and there is much, points in one unmistakable direction, namely, that to furnish the customer with free lamps is one of the most satisfactory and best paying schemes yet introduced in the electric lighting field. The lamps must not be sold at cost, or below cost, or on any such scheme. "Free" has only one meaning, so far as this question is concerned. As an illustration of a condition which may result from the "cost" or "below cost" idea, we would cite a case which recently came to our attention. A local company supplied a high efficiency lamp at the exact cost of the article to them. Competition from an enterprising merchant was experienced, said merchant selling a low efficiency, cheap grade lamp, and using as an argument the statement that it was better in the long run to buy lamps from him, for while they cost a little more, the longer life of the lamp soon made up the difference. It will be appreciated by those who have to deal with the public that this was a forceful argument, and one exceedingly difficult to overcome. To bring in technicalities and show that the saving in current effected by the high efficiency lamp more than compensated for the more frequent renewals is almost useless, for, no matter how much it may be regretted, the consumer often regards the electric company in a far from charitable light, and will likely doubt such a statement. An electric company has competition and serious competition at that. Gas, coal oil, and acetylene, are serious rivals in the lighting field, and it is seldom that the electric company can offer the prospective customer a saving in his light bills. On the other hand, there can be offered a safer and more convenient form of illumination, and if the local manager can truthfully say in addition to these points "a better light," he should get every bit of business in his section. But if his customers buy their own lamps, he cannot say this now, and he never will be able to say it. The lamps in use are as much a part of an electric lighting system as the transformers, the poles, or the generators and engines, and the same careful attention required by and given to these latter items must be devoted to the first. We thoroughly believe in this matter, and we think that every intelligent central station manager who gives consideration to the question will come to agree with us. Those companies which have adopted the idea have been well paid, whether the plant was on a large or a small scale. Are *you* supplying free lamps? If not, why not? Now is the time to take this matter up, for the season of heavy lighting is at hand, and the old lamps which have managed to burn along through the summer will soon be thrown out. Are you going to let your customers keep on buying inferior, low efficiency, poor grade, long life lamps, and be thoroughly dissatisfied with the service you are furnishing, or are you going to treat the matter as it should be treated, and have all your customers contented? To those central stations driven by steam and supplying energy on a flat rate we would point out that a change from a four watt to a three and one-tenth watt lamp will make a reduction in the coal bill of almost twenty per cent. Is not this worth while?

On Other Lights. Probably one of the cheapest illuminants is coal oil, when calculation is made on a candle power basis, but breakages of glassware, etc., should be added for this form of light, and this is seldom done. Two great dangers are encountered in connection with the use of coal oil, one being the explosion of the lamp and the consequent scattering of the burning oil, and the other the breakage of the oil containing vessel, which act will spread the oil and very probably ignite it. In either accident the fire hazard is very great, and the burning material, namely, oil saturated carpets and perhaps articles of clothing, is very difficult to extinguish. Such accidents happen quickly, and it is very doubtful if the proper appliances will be found at hand to extinguish the flames before great damage has been done and possibly lives lost. Good coal oil itself will not light unless raised to a fairly high temperature, but of course when some fabric is immersed in the liquid there is no doubt about the ignition. With the poorer grades of oil the lighting point is much lower, and in the ordinary types of lamps the construction is so bad that the required temperature may easily be reached while the lamp is in operation. Hence it is probable that in the great majority of cases the oil will light instantly should the lamp be broken, even though setting on an uncovered table. There is no question but that coal oil, while having cheapness to recommend it, is the most dangerous form of light, but while dangerous in itself it has a greatly increased hazard in being portable. If coal oil lamps were all built stationary the risk would be greatly reduced, but without the portable feature it is likely that their use would be entirely dropped. With the gas jet we have two dangers also. The first is the explosion hazard and the second asphyxiation. With the reasonable exercise of common sense this first should be entirely eliminated, but the fact remains that in the past people have looked for escaping gas with a light, and without doubt they will continue to do so in the future. Accidents from this source may be attributed to pure carlessness, and the cure of the evil lies within the powers of each individual. Explosion may come from one other source, but this will be dealt with later. Asphyxiation is the direct result of the inhalation of the gas, but two effects, each entirely separate and distinct, may be noted in the action. The first is the production of unconsciousness, the same being similiar to the action of nitrogen monoxide or "laughing gas" and other similar gases, and the second being a very active poisoning. A person might be kept unconscious with nitrogen monoxide for a number of hours, at the end of which time recovery would be rapid and little or no after effects would be experienced. Here there is no poisoning. But should a person be subjected for the same length of time to illuminating gas, recovery would be very questionable, on account of the severe poison taken into the system. The practice of retiring at night and leaving a jet burning is dangerous to say the least, for should the flame be blown out by a draft, the gas will continue to flow until the cock is turned off. In winter, the chances of having a burning light extinguished are very great, for the following reason. The popular theory that gas or gas-pipes will freeze is of course erroneous. What does freeze is the moisture which is carried into the pipes with the gas. It is possible that where a portion of a pipe is exposed to frost, that moisture coming over with the gas will congeal at this point, and there is risk of the pipe being closed entirely by a continued action along this line. If a person has retired and has left a jet burning, the freezing moisture may be cut off the gas for a time, and then, should a change of temperature occur before morning, allow the flow to continue, and then the gas would escape into the room and possibly cause asphyxiation. If two burners are left going at night, it is possible that one may be extinguished by this freezing and thawing action in the local pipe, and that the gas which escapes into the room as a result will be ignited by the other burner. This is the second source of explosion mentioned previously. The practice of putting an acetylene generator in the cellar of a house will sooner or later make trouble of some kind, and we feel sure that the idea will be given up entirely in the near future. Acetylene, taking all things into consideration, is a safer light than coal oil, and about the equal of ordinary gas. The generator is the danger point, and this is why it should be located in a separate out-house. The gas may be more explosive than coal gas, but there is one point which counteracts this undesirable feature. While acetylene will produce asphyxia, the fatal result of the coal gas is not to be found and the poisoning, comparatively speaking, is very mild. Another good feature is the pungent odor of acetylene, which facilitates the detection and finding of a leak. But regarding this leak question, our remarks on leaks of coal gas apply with equal force here, namely, do not look for the trouble with a light. Acetylene has been condemned in the past, as a large number of accidents have resulted from its use. These lighting systems have been placed in the hands of farmers not above ordinary intelligence, and it is surprising that more fatalaties have not occurred. One man buys a good generator, and has a safe plant, and his neighbor, who is a handy sort of a person, builds a machine himself, uses it, and is, perhaps, blown up. Following this comes a cry from the newspapers condemning acetylene, in every shape or form, and this, to say the least, is most unfair. The party from the country comes into a city hotel and blows out the gas, with inconvenient results, and the papers sneer at the lack of intelligence on the part of the deceased. Far more foolish actions are the cause of many of the recorded explosions of acetylene, but here the system is blamed instead of the individual. Acetylene is a good thing, and will, we think, grow to be a serious rival of electricity. But without question, the electric light is the best, the safest, and most convenient form of illuminant, and coal oil, coal gas, or acetylene, can never be compared wiht it. We place the above facts before our readers so that they may be posted on the various points when going out to secure contracts. We have competition, and will have still more, but the thought that we have an almost ideal form of light should make us feel well satisfied, and should enable us to get and keep a great percentage of the business.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All questions will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

Ques. No. 1.—Will you kindly explain to me what a "differentially-wound" motor is?

Ans.—We presume that you are acquainted with the standard types of field winding, but will run over roughly the various methods of winding and connecting the coils. The most common winding is the shunt, in which the field is excited direct from the supply circuit and independently of all other parts of the motor. The result of this connection is that the field strength of the machine remains practically constant, and we have, as a result, a machine which runs at a constant speed, that is to say, the maximum variation of the number of revolutions per minute will not exceed five per cent. in a properly designed, fair sized motor. This type of winding is universally used for power work in factories, etc. The next winding is the series, which is used to a great extent for elevator work, and almost exclusively for railways. In this type the field winding is of heavy wire, and is connected in series with the armature, all the current passing through the armature passing through the field also. It therefore follows that when the motor is carrying a heavy load and drawing a large current, the field is very strongly excited, and hence the speed of the machine will be reduced. In this way, the motor has a load-regulating tendency, for if the load be increased the speed immediately drops, which action naturally tends to reduce the load which the machine is actually taking care of. If, on the other hand, the load on a series motor be taken off, the armature current is lowered, and this in turn weakens the field and hence the motor speeds up greatly. Series motors, for this reason, must be carefully watched, for if the load should be suddenly reduced, unknown to the attendent, by such an action as the breaking of a belt, the speed will reach such a high point that destruction may follow, due to the immense centrifugal force. If a machine were built having a shunt and series winding on the fields, the motor would have the valuable load-regulating feature (but not to such a marked extent as would be found in a straight series motor) and would not run away on light load. This is the compound wound motor. It is used on elevator work where the series machine would not give satisfactory results, and has many other fields where the combination of the two previously mentioned features is desirable. An instance can be cited in the case of a punch press. Here it is desired to do the actual punching by the energy stored up in the fly-wheel, and the motor which drives such a press must not reach a dangerous speed when the press wheel is running but the press not working; also, when the actual punching is done, and the speed ofthe fly-wheel and motor is dragged down for an instant, the machine must not take excessive current. The shunt winding of the compound motor prevents the running away, and the series winding prevents the taking of too heavy a current when the speed is reduced. From this it will be seen that the compound motor is an ideal machine for driving punch presses. In the differentially wound motor we have a machine with a shunt and series winding, as in the compound motor, but the difference is that in the former the series field is reversed. This means that when the load is increased the series coils tend to weaken the field, and instead of the speed dropping, it stays constant, or increases. This will of course depend on the ratio of the two windings, for a given machine may be designed to give almost any desired result. Suppose that in a certain motor, the drop in speed from no load to full load, with a shunt winding only, is fifty revolutions per minute. The addition of a series field, reversed so as to make the machine differentially wound, may, dedepending on the number of turns in this series field, give a drop of but twenty-five revolutions, or it may make the speed constant at all loads, or on the other hand, it may make the machine increase in speed as the load increases. Very few differentially wound motors are used, as they have serious disadvantages. Where an absolutely constant speed is required, irrespective of load, is one place for such a motor, but while no trouble will be experiencied if the load changes are gradual, still if a sudden increase in load occur, the motor is liable to run away and blow the fuses. This will be understood by remembering that the series field is opposed to the shunt, and therefore if the increase in load be severe, the series field may completely overpower the shunt field, and the result will be disastrous, the machine being left without any field at all. Another point is that if a differentially wound motor starts to run away, there is no holding it, unless the switch be pulled, and this though it may take but a few seconds will likely give the machine a chance to damage itself. Starting must be carefully done, for the same reasons. While the differentially wound machine is of great value under certain circumstances, it must never be placed in the hands of an inexperienced person who does not understand it thoroughly.

Ques. No. 2.—When used as a penstock, is the friction greater in an iron pipe than in a wooden one, and how does this vary with age?

Ans.—Considering only iron and wooden pipes which are properly built, it is safe to say that the friction in a new iron pipe of a certain size will be from ten to thirty per cent. greater than that in a wooden pipe of the same diameter. With age, the difference becomes more marked, as the friction in an iron pipe increases while that in a wooden pipe decreases. In an iron pipe, we have the joints, the rivet heads, and the roughness of the iron itself, all of which cannot be materially reduced, and which are material friction factors. On the other hand, the staves of a wooden pipe may be planed very smooth before the pipe is built, the transverse joints can be made practically smooth, and the lateral joints count for nothing. The longer wooden pipe is used, the smoother it becomes inside, owing to the action of the water, and to the formation of a slippery green slime. In making up such a pipe, it is the custom to dress the insides of the staves so that when put together the whole will form a practically perfect circle. It is a surprising fact that while wooden pipe was used altogether in the early days of hydraulic engineering, steel and iron pipe seems to have supplanted it to a great extent, even where the heads have been very moderate. There appears to be no very good reason for this, as the wooden pipe costs less, is easier built, lasts longer, and has, for a given diameter, a considerable greater carrying capacity.

THE USE OE PORTABLE SUBSTATIONS.

American practice in the field of urban electric railways has conclusively proved the value of portable substation as a necessary expedient on lines having a normally light traffic but subject to heavy rushes of load at certain times. Numerous types of these portable stations have been put into service, and considerable interest attaches to their equipment. In a recent issue of the Street Railway Journal Mr. J. R. Hewett described a station built for the Cincinnati and Columbus Traction Company. From this article we cull the following data:—The equipment under consideration at present forms a 400 k. w. plant. In this instance the machinery and apparatus are installed in a freight car of standard design. Great attention has been paid to the location of the heavier units, to avoid undue strain being brought on any part of the car or machinery during the time it is in motion. The rotary converter is placed at one end of the car and the transformer at the other, in each case the centre of gravity being immediately over the truck. An equipment consisting of a rotary converter and transformer has been found by experience to be preferable to employing a synchronous motor generator set. The former not only has the advantage as regards weight, but it is also less costly, has a better overload capacity, and the connections are simpler. Added to this, were a motor generator set installed, it would involve the use of an exciter set and a high-voltage starting compensator and switches.

The rotary converter installed in the Cincinnati and Columbus substation is a six-pole, three-phase machine, with a normal output of 400 k. w. when running at 500 revolutions per minute. The potential at the d. c. brushes is 600 volts. It is fitted with a speed-limiting device connected up in such a manner as to open the d. c. circuit breaker in case the speed rises above the normal, due to a failure in the a. c. power circuit, when the converter would run as a d. c. motor with a differential field.

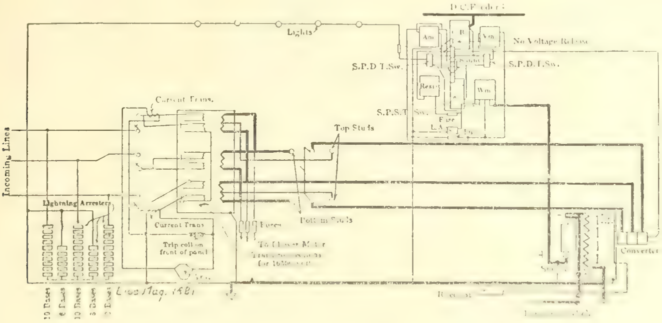


FIG. 1.—DIAGRAM OF CONNECTIONS OF PORTABLE SUBSTATION.

In the early portable substations three single-phase transformers were employed. But this was only due to the fact that such apparatus could be obtained at the works ready for immediate use. In the present case, one tri-phase transformer has been installed, and this arrangement possesses the two-fold advantage of being light in weight and occupying a minimum floor space. It is designed for a capacity of 440 k. w., is a 25 cycle unit, and the primary is wound for both 33,000 and 16,500 volts, while the secondary delivers current at a pressure of 370 volts. The blower set for supplying the air-blast consists of an ordinary rotary blower, direct-coupled to an induction motor. No high-tension apparatus is brought in front of the transformer, a factor which ensures the safety of the substation attendant. The usual form of low tension a. c. starting switch is reretained, and no d. c. starting rheostat switch or synchronizing apparatus is included in the equipment. Both power factor indicator and a. c. voltmeter are also dispensed with. No negative switch is provided, the negative terminals of the machine being connected directly to the metal truck, which is, of course, in metallic connection with the track. The rotary converter is compound wound, with the series coil on the negative side—that is to say, between the armature and ground connection. An equalizer switch is provided on the negative side of the machine for use when the car is in operation as a reserve to a permanent substation close at hand. The equalizer switch running to a flexible jumper can readily be connected to the equalizer bus bar in the neighboring substation; and, again, the jumper can be connected to the ground should it become desirable to run the converter as a shunt-wound machine.

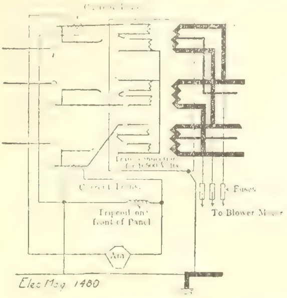


FIG. 2.—TRANSFORMER CONNECTIONS FOR PORTABLE SUBSTATION.

The substation can be lighted from either the trolley of the rotary converter; and the voltmeter is provided with a double-throw switch to permit readings being taken of either the trolley or machine voltage at will. A flexible lead is taken through the wall of the car directly from the machine circuit breaker to a terminal block on the outside, so that connections may readily be made to the trolley wire, d. c. feeder, or positive bus bar in the permanent substation, as occasion demands. The a. c. leads are carried out through a special weather-proof entrance, and from this point connections are made to the overhead high-tension transmission lines.

The end of the car near which the rotary converter is located is made detachable, to facilitate installation. The rotary converter is held in position by wooden cleats, which fit snugly to the interior form of the base, and provision is also made for levelling the rotary converter, should it be found necessary for the substation to be operated on a grade. All the wiring from the transformer to the rotary converter is carried under the floor.

Figs. 1 and 2 show the scheme of connections diagrammatically. In the former the transformer connections are for 16,500 volts, and in the latter for 33,000 volts.

The approximate dimensions of the car are:

Length	41 ft.
Width	9 ft.
Height	8 ft. 6 in.

The car is fitted with hand brakes, but no motors are installed, as their occasional use would hardly justify the extra expense. When the substation is moved, it is drawn by a motor car. During transit over the steam railroads, standard M. C. B. wheels are used, but when the car reaches its destination, these are replaced by wheels of narrower tread and shallower flanges, suitable for running over city lines, switches and points, as well as rounding curves, etc. Cars for operating on lines where little clearance is provided between the top of cars and bridges can be supplied with hand brake rigging mounted below the roof line.

A NEW SYSTEM OF STREET LIGHTING.

Publicity has recently been given to an arc lighting system employing the mercury vapour rectifier as the "changing medium between the lamps and the generators." The following details describe generally the system adopted:

The feature of the system is the operation of direct current arc lamps, of either the carbon or luminous arc type, from an alternating current supply by means of a constant current transformer and a mercury arc rectifier, thus obtaining both the excellent light of the direct current lamps and the perfect regulation of the constant current transformer, through the medium of a reliable, efficient and simple piece of apparatus.

The remarkable properties of the mercury arc rectifier for low-voltage applications are now well known through the recent introduction of the battery-charging rectifier panels. Therefore, no theoretical discussion of the rectifier tubes will be attempted. A few changes in shape from the form of the low-voltage tubes have been found advisable, and a few additional precautions are taken in manufacture, on account of the high voltage to which the tubes are subjected when operating series street lighting circuits. Naturally, difficulties have been met in handling high voltages, but they have not proved insurmountable, and to-day 25,000 volts are handled with the rectifier much more easily than one-hundredth of this voltage was controlled only a few years ago.

The transformer used to supply the lighting circuit through the rectifier is of the well known constant current type, air cooled except in the largest sizes, where, on account of high voltage, oil cooling is preferable. It differs from the standard type only in that it requires a specially wound secondary, having a smaller section of wire and greater number of turns than is usually employed. These special secondaries are usually wound in two coils, thus giving a convenient neutral point to which the negative terminal of the road is connected.

The first commercial installation of luminous arc lamps operated from a rectifier was made by the Schenectady Illuminating Company in March, 1905. The lamps are placed on Dock Street, Lyon Street, and Edison Avenue, and have been operated from the rectifier without the slightest trouble or interruption since that time, thus confirming the results of earlier tests, that the system is efficient and reliable.

The rectifier is mounted on a pivoted support on the front of the arc light controlling panel. A modification of this arrangement adopted in later sets has been to mount the rectifier on a small marble base and to mount this base above and back from that part of the panel on which the operating switches are located. This arrangement entirely avoids the presence of high-potential terminals on the front of the panel. A small transformer supplies low-voltage alternating current to a pair of auxiliary starting anodes; consequently, the rectifier may be started before any of the high-tension plugs are thrown in. After starting the rectifier it is necessary only to plug in the circuit and transformer plug switches, starting as though the system were series alternating.

The efficiency of the rectifier system is practically the same as that of the constant current series alternating arc light system, since at the high voltages used the loss in the rectifier becomes almost negligible. In light efficiency, however, the rectifier luminous arc system shows a marked advantage, on account of the great increase of light given by the luminous arc lamp at approximately three-quarters the energy. Although the same increase of light, due to the use of the magnetic arc lamp, may be obtained from a motor-driven arc light dynamo, there can be no comparison between this method of operation and the rectifier, either in efficiency of the system, amount of apparatus, or ease of operation.

The Board of Trade of St. John, N.B., have appointed a committee to enquire into the feasibilty of obtaining cheap power from a near-by falls, a project brought up recently by William Thompson & Company.

The British Columbia Electric Railway Company are considering the building of an electric railway from New Westminster to the Fraser River saw mills at Millside. It would mean an expenditure of approximately $35,000.

The improvements to the electric light plant at Parry Sound, Ont., have been completed. A flume 130 feet long has been built, the power house remodeled and a new revolving field alternator installed. The power has been increased to 700 h.p.

CANADIAN ELECTRICAL ASSOCIATION.

A meeting of the Executive Committee was held at the Secretary's office, Toronto, on the 11th inst., when a number of new members were elected.

Owing to his removal to New York, Mr. K. B. Thornton, ex-President, tendered his resignation as a member of the committee. Mr. James Robertson, of the Montreal Light, Heat & Power Company, was elected as his successor.

A letter was read from the Institution of Electrical Engineers of Great Britain tendering to the Canadian Electrical Association an invitation to visit England during the latter part of the month of June next as the guests of the Institution. The Secretary was directed to express the thanks of the Association for the invitation and communicate with the members to learn if any of them will be in a position to avail themselves of it.

Messrs. R. G. Black and James Robertson were appointed a committee to secure suitable papers for the annual convention of 1906. The following gentlemen were appointed a committee to make the necessary local arrangements for this convention:—Messrs. R. B. Hamilton, manager Packard Electric Company, St. Catharines; J. A. Kammerer and J. W. Campbell, Toronto; P. J. Myler, manager Canadian Westinghouse Company, Hamilton, with power to add to their number. It was suggested to this committee that if possible the convention be held during the first two weeks in June.

Mr. R. G. Black was appointed Chairman of the Committee for the advancement of the interests of the Association. Mr. T. S. Young was appointed Assistant to the Secretary of the Association.

TORONTO BRANCH A. I. E. E.

The twenty-fifth annual meeting of the Toronto Branch of the American Institute of Electrical Engineers was held at the Engineers' Club rooms, 96 King street west, on Friday evening, November 10th. The subject for discussion was "Lightning Arresters," which was introduced by Mr. C. H. Wright, who gave an abstract of a paper read before the parent institute by Mr. N. J. Neall. This paper describes a method of obtaining, by means of test papers, records of the operation of lightning arresters in service and gives some results obtained by the use of this method on several transmission lines. The test papers were furnished by the Westinghouse Electric & Manufacturing Company to a number of operating companies about eighteen months ago and the tests covered territory extending from Maine to California. The character of the puncture made in the test papers, which were inserted between the discharge points of the arresters, is believed to indicate not only that a discharge had taken place, but also to show its character and thus give evidence of the suitability of the protective apparatus employed. The range in voltage of the high tension plants on which experiments were made extended from 6,600 to 55,000.

The test papers are stated to indicate that the lightning disturbances on a line are not of the magnitude generally supposed. A comparison of the lightning arrester papers punctured in practice with the papers taken from idle lines led to the belief that the low-equivalent arrester was discharging these disturbances almost as freely as if the resistances were omitted. The results showed clearly that for freedom of discharge the arresters which are built like the low equivalent with low resistance have freer discharge than the straight gaps and high resistance.

Mr. Wright strongly commended the Westinghouse Company for the work which they had undertaken, and which he believed would eventually lead to a more perfect knowledge of the characteristics of lightning discharges. He regarded Mr. Neall's paper as a very valuable addition to scientific literature.

An interesting discussion followed Mr. Wright's remarks, in which Messrs. H. A. Moore, R. G. Black, K. L. Aitken, E. B. Merrill, W. G. Chase, E. Richards and F. A. Gaby were participants. Mr. Moore urged that the electrical fraternity of Canada take some steps to ascertain the effect of lightning discharges upon transmission lines in this country, where climatic conditions are different from those of the United States. No particular type of arrester, he claimed, could meet the requirements of all lines and all conditions. Mr. Black advised that fuses be placed on both sides of lightning arresters to prevent them from short circuiting. If he were building a line he would have a plain wire above, with a large number of lightning arresters. Mr. Merrill described briefly what the Toronto and Niagara Power Company are doing in the way of lightning protection. During the discussion the horn type of arrester, which had been discredited by some engineers, was the subject of favorable comment. It has been used very successfully on the transmission line of the Shawinigan Water and Power Company between Montreal and Shawinigan Falls, and since their installation they have had no arcs in their station, no damage to apparatus, and no interruption to their service caused directly by lightning. This type of arrester is evidently used largely in Italy, as Mr. Philip Torchio, in a paper read at the last Institute meeting in New York, states that the best practice in Italy consists in placing horn arresters on the line at the station, making the ground connection through a water rheostat.

MONTREAL

Branch office of Canadin Electrical News,
38 Alliance Building.

November 4th, 1905.

Last year the Montreal Street Railway caused considerable comment by leasing one of their cars, as an observation car, to a Buffalo concern. The business public thought it strange that the company did not run it themselves. The cab drivers fought the scheme tooth and nail. This year the company are running it themselves, and utilizing the fine new open car that made its debut at the late C.E.A. convention in Montreal. The business men nod approval, the tourists are satisfied, and even the cab driver has not been heard against this latest scheme.

It is a pity that much cannot be said for the new double entrance closed cars numbered from 900 upwards, that the Montreal Street Railway Company have placed on the St. Catherine street route. The idea is to prevent one from securing a ride for nothing by compelling payment on entering. Whilst a man can get his cash or ticket easily, or should be able to do so, it is a different matter with the ladies, and surely they are not the ones that cause the Montreal Street Railway to mourn the loss of so many fares? An exception might surely be made in their case, as encumbered with parcels and passing through a phalanx of smokers, it is hardly to be wondered at that the ladies object to such "stand and deliver" methods.

The Bell Telephone Company deserve great credit for the success which attended the turning over their main exchange to central energy system. Saturday we turned magnetos, Monday we did not. No time lost, and complaints were few and far between. It would be interesting to learn from that company's engineers if ever another exchange of such magnitude was changed over in such a manner and without loss of service.

THE BRAIM AUTOMATIC SWITCH.

A company has been formed in Vancouver, B. C., for the purpose of placing on the market a patent switch turning device, the invention of Mr. W. H. Braim, of that city. This switch was first introduced about two years ago, at which time it was taken up by the British Columbia Electric Railway Company, and after several satisfactory tests was installed throughout their system.

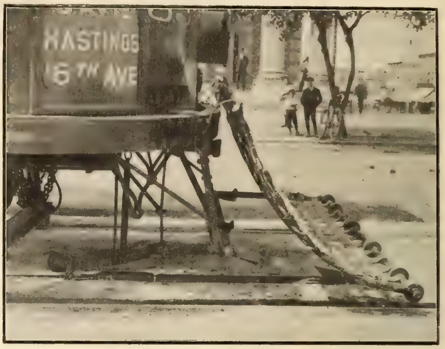
The device, while unique itself, is very simple in operation. It consists of three distinct parts, each, of course, operating on the other. The first part is that with which the cars are equipped, being a long pin or tread acting on a shoe made suitable to engage either catch to throw switch for main line or branch as desired. The top of this pin protrudes through the platform of the car in a convenient place for the motorman to operate, which is done by the pressure of the foot.

The other parts are placed on the ties at the switch and consist of two cast iron boxes and a common T rail about five feet long. This rail is simply for the lower end of the shoe to travel along when pressed downward by the motorman as the car approaches the switch. At the end of this rail nearest the switch is located one of the cast iron boxes. This box is about 6 feet long by 4½ inches wide, rising level with the rails. Near each end of the box is a small case hardened catch or block, one or the other of which the lower end of the shoe on the car strikes. These little blocks slide forward or backwards in a guide frame and are made to work opposite one from the other by means of a flexible connection (either chain or cable) working around a pulley located inside the box. Thus when the shoe strikes one of the blocks throwing it forward, the other one being connected to it by the cable is immediately thrown back in readiness for the reverse operation.

Along side the switch and in line with the first mentioned box is placed another cast iron box. This one is nearly square, being 16 x 18 inches, and rises level with the pavement. This box contains a T shaped lever; to one end of the short arm of this lever a link is attached, the other end of the link being connected direct onto the switch point. It might be mentioned in passing that this link is in two pieces, the connecting ends being threaded to permit of perfect adjustment in the play of the link on the switch.

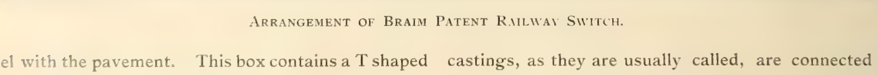
Coming back to the long box, we find a long shaft or sliding rod running from it to the second box. This rod has a sliding play of about six inches and is operated by the two catches at each end of the longer box. It is connected at the other end onto the long end of the T shaped lever in the square box.

Let us suppose now that a main line car is approaching a switch that has been thrown over for the branch line. The motorman presses down the trip with his foot as the car approaches the first catch situated in the forward end of the long casting. The toe of the shoe striking this catch immediately shoots the long sliding shaft forward, which shaft, pulling at the long end of the T lever in the other casting, causes its short arm to move about two inches. The connecting link, being attached to the short arm of this lever, instantly moves with it, and it (the link) being also connected to the switch point, pulls the switch point over, permitting the car to continue on the main line. If a branch line car is approaching the switch when it is thrown for the main line, the motorman of the branch line car allows the shoe to pass over the first catch and striking the second causes a reverse movement of the long sliding shaft, thereby moving the switch point over for the branch line as desired.



Braim Patent Railway Switch—The Depressible Shoe is About to Strike the Trigger of Switch.

The object of placing the first box so far back is to allow the motorman to see that the switch has been moved over before the car enters. The two boxes or castings, as they are usually called, are connected to each other by a piece of piping which also serves to encase the long sliding shaft.



Arrangement of Braim Patent Railway Switch.

The following are the instructions that have been issued by the British Columbia Electric Railway Company to their employees for the installing and operating of the switch-thrower :

DIRECTIONS RE. INSTALLATION.

The switching device consists of two parts, the switch throwing lever attached to the car-body and the device installed on the street railway track between the rails.

To install, first drill the tongue switch about 22 back from the tongue, making a rectangular hole 1½" × 1⅛" as per separate detail; fit the dog to tongue and connect to the lever in cast-iron box by the connecting rod provided. Then place the 1½" wrought iron pipe that serves as a cover for the long connecting rod in position, fitting one end in the square box and the other end in the long casting, driving the pipe into place to the mark on the pipe.

Connect up the levers and the chain to the two triggers, making sure that all parts are in line and work easily before spiking down.

Spike down a short length of rail about 6 ft. long for the shoe on switch to run on.

In equipping car with switch thrower make sure it is the same distance from gauge line of rail as the triggers on the track and see that the shoe and lever have not too much side play.

The operating rod in floor of the vestibule can be off-set to bring it into the best location for the motormen's use. This position will naturally vary with the different types of vestibules.

DIRECTIONS TO MOTORMEN TO THROW SWITCH.

To throw switch for main line press the pin just as first trigger in long casting rod disappears under the fender, holding shoe steadily until switch is thrown.

To throw for branch line press the pin at the second trigger just as the one nearest switch disappears under the fender. Always slow car down to 2 miles an hour when operating switch thrower, and release foot from pin as soon as the switch is thrown.

ELECTRIC COMPANIES IN DISPUTE.

As a result of an electric fire, which burned out a whole light and power circuit at the power house of the Montreal Light, Heat and Power Company and temporarily tied up the street car service, the latter company has entered suit against S. Carsley, of the Central Electric Company, for $150,000 damages, and applied for an injunction to prevent the latter company from stringing wires as heretofore.

The Montreal Company say that the fire was caused by one of the Central Company's wires, which crossed their 10,000 volt wire, falling on to their wire. The immediate result was a short circuit.

The Carsley system was started for his own departmental store, and was extended by running the wires over the roof, etc., to supply other nearby merchants.

The management of the Montreal Light, Heat and Power Company issued the following statement respecting the trouble:

"Due to gross carelessness on the part of the emloyees of the Central Electric Company, the system of he Montreal Light, Heat and Power Company was seriously interrupted yesterday morning. Employees of the Central Electric Company by stringing wires over the high tension lines of the Light, Heat and Power Company on McGill street, burnt the same down, which caused a complete shut down of all services fed from the Light, Heat and Power Company's central station, which seriously affected the operation of the Montreal Street Railway Company. It is miraculous that there were not a number of people killed due to this carelessness. Considerable damage has been done to the system of the Montreal Light, Heat and Power Company, as well as the Street Railway Company."

AN IMPORTANT DECISION.

An important decision has been rendered by Judge Andrews in the case of the Guardian Fire and Insurance Company vs. the Quebec Railway, Light and Power Company, which was an action for $2,300, and also in the action of the Union Assurance Society for $2,565, against the said company, both actions being dismissed with costs.

The Insurance Companies were endeavoring to recover from the Quebec Railway, Light and Power Company the above amounts, paid by them to J. B. Morrissette and wife for damage to their property, caused by fire about October 18th, 1903.

The Insurance Companies claim that the Quebec Railway, Light and Power Company were responsible for the damage. The case was a very important one, and the trial lasted almost two weeks. There were nine expert witnesses retained by the plaintiffs and defendants. The technical side of the Quebec Railway, Light and Power Company's case was placed in the hands of Mr. R. S. Kelsch, consulting engineer, Montreal.

From the evidence given, it was learned that the transformer supplying current to Mr. Morrissette's house failed on the night of the fire. The record of the weather conditions for that night, however, were such as to show that a very severe thunder-storm, accompanied by sharp lightning discharges, occurred, and that, furthermore, the wiring in Mr. Morrissette's house was defective in several respects. The evidence also showed that the wiring was done by a man who knew nothing about the business, and even the Fire Underwriters' experts were obliged to admit that it was very defective.

In one place concealed work was done with ordinary lamp cord, which was twisted around a lead pipe, ¼-inch lead pipe being used throughout the building for connecting the various gas fixtures.

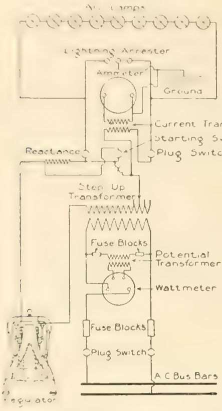
MOONLIGHT SCHEDULE FOR DECEMBER.

Date.	Light.	Date.	Extinguish.	No. of Hours.
Dec. 1	5 00	Dec. 2	6 30	13 30
2	5 00	3	6 30	13 30
3	10 30	4	6 30	8 00
4	11 30	5	6 30	7 00
6	0 20	6	6 30	6 10
7	1 15	7	6 30	5 15
8	2 15	8	6 30	4 15
9	3 10	9	6 30	3 20
10	4 10	10	6 30	2 20
11	No Light	11	No Light	..
12	5 00	12	7 00	2 00
13	5 00	13	7 50	2 50
14	5 00	14	8 50	3 50
15	5 00	15	9 50	4 50
16	5 00	16	10 50	5 50
17	5 00	18	0 00	7 00
18	5 00	19	1 00	8 00
19	5 00	20	2 10	9 10
20	5 00	21	3 20	10 20
21	5 00	22	4 30	11 30
22	5 00	23	5 40	12 40
23	5 00	24	6 45	13 45
24	5 00	25	6 45	13 [illegible]
25	5 00	26	6 45	13 45
26	5 00	27	6 45	13 45
27	5 00	28	6 45	13 45
28	5 10	29	6 45	13 35
29	5 10	30	6 45	13 35
30	5 10	31	6 45	13 35
31	5 10	Jan. 1	6 45	13 35
		Total	..	[illegible]

INVENTION *and* DEVELOPMENT

IN THE ELECTRICAL FIELD

Series Alternating Current System for Arc Lighting. The Fort Wayne Electric Company, of Fort Wayne, Ind., have recently developed a system for series arc-lighting circuits which may readily be operated upon a constant-potential supply. The system has been designed for a frequency of either 60 or 140 cycles, and consists of a regulator for maintaining a constant current, a specially designed high-tension switchboard, a constant-potential transformer, and a series of arc lamps. The regulator depends upon the automatic introduction of impedance into the lamp circuit whenever any decrease in the resistance of the latter would tend to cause an excessive current to flow. This impedance is introduced by the combined movements of a laminated iron core and impedance coil into such a position as to cause a greater magnetic flux to be cut by the current in the coils. This increase in the amount of flux cut by the line current produces a choking effect, reducing the latter to its normal value. If, for any reason, the line current be decreased, the exact opposite effect takes place within the regulator, and the current is automatically increased to its normal value. By reference to the accompanying diagram, the peculiar design will be noted by means of which, it is claimed, the system may be quickly started from the switchboard without paying any attention to the regulator and without causing any excessive rush of current through either the regulator or the lamps.



CONNECTIONS FOR FORT WAYNE SERIES ALTERNATING-CURRENT SYSTEM OF ARC LIGHTING.

The Tantalum Lamp.—Concerning the tantalum lamp, Mr. V. Zingler, of Siemens Bros. & Company, London, Eng., says: "Many hundreds of thousands of these lamps have now been sold, and a considerable amount of experience with regard to their behavior has been obtained. As a result, it has been shown that when used on alternating-current circuits the results are not so good as on continuous-current circuits, the life of the lamp frequently being considerably shortened, and the globe showing a tendency to blacken. We therefore recommend that, for the present, the use of tantalum lamps should be restricted as far as possibe to continuous-current circuits. We are frequently asked to state the life of the lamps. Of course, as regards individual lamps, it is as impossible to make any statement as with any carbon filament lamp, but experience has shown that on continuous-current circuits the useful life may be assumed generally as being between 400 and 600 hours, and in many cases it is actually even larger, whilst the total life often greatly exceeds 1,000 hours. We have previously informed you that the candle-powers of the lamps of various voltages are proportional to the standard candle-power of the 110 volt lamp (23 British candle-power). We have had many enquiries as to why we do not put the 110 volt lamp on the market with a candle-power somewhere about 16, the general opinion being that 23 c.p. was too high for most requirements, although the current consumed is actually less than for the carbon filament lamp of 16 c.p. According to present manufacturing arrangements, in order to reduce the candle-power, it is necessary to have a lower voltage lamp, so as to secure the same high efficiency. We are now prepared to accept orders for 2.2 watt lamps for pressures of 50, 55, 60, 65, 73-75, 100 and 110 volts. These lamps have a useful life of about double the duration of the lamps described above, and give 30 to 40 per cent. less light, with an efficiency at starting of 2.2 to 2.4 watts per candle-power. For instance, the 110 volt lamp of this type gives a light of about 14½ c.p., with an efficiency of 2.2 watts per candle-power. Its useful life is about 800 to 1,000 hours, and the total life often reaches 1,500 to 2,000 hours. With the efficiency mentioned, a lamp having such a long useful life is, you will no doubt agree, a great improvement on anything that has been done in connection with carbon filament lamps."

Terminal Covering for Lead-Armored Cable.—Chas. E. Teush and Luther Agis, of Evansville, Ind., have patented a moisture-proof cable covering which contains some points of advantage. The invention consists of a sleeve of lead or other suitable material forming a case-covering for the splices and joints. This covering is healed or completely closed at one end, while the other end is "sweated" to a collar of brass or other suitable material provided with a screw thread on its outer extremity to fit the internally screw-threaded lower end of a cap of brass or other metal. This cap is provided with an internal annular ledge and an extended rim or margin above the ledge, creating, with a lead gasket resting upon the ledge, a shallow cup on the top of the complete casing. The gasket is provided with a series of holes for the reception of any number of lead-armored cables that it may be desired to use, hot solder being poured around the cables in the shallow cup formed, preferably until the solder rises to a line a little above the top of the cap. By the use of this device it will be seen that to reach the terminal wires to make splices or tests all that is necessary is to unscrew the brass collar from the cap, when the hollow casing may be removed and the wires exposed.

Improvement in Telephone System.—Mr. Charles E. Egan, of Chicago, has been granted a patent on a telephone system and has assigned same to the Egan Electric and Telephone Company, of Petersburg, Ill. The invention relates to improvements in telephone systems in which a number of telephones are arranged on a single circuit, and the object is to provide a simple means whereby the operator at the central station may cut out the coil and bell circuits of all the intermediate telephones while conversation is held between two subscribers at the remote stations, thus reducing the resistance in the talking-circuit. In carrying out the invention, a circuit controller is employed comprising a metal plate adapted to form part of the circuit. Chambers are arranged in the circuit and have corrugated expansive inner walls. Swinging rods have connection with these walls, and are adapted to operate a circuit controller. Heat coils are located in the chambers, and means are provided at a central office for controlling the heat coils.

Direct Current Series Power Transmission System.—A British exchange tells of an interesting high tension direct current transmission scheme. The transmission is between Montiers, in Savoy, and the town of Lyons, and is over a distance of 110 miles—the greatest yet undertaken in Europe. The power to be transmitted is 6,500 h.p., and it is to be generated at 57,000 volts. This will be obtained by connecting four groups of generators in series, each group being directly driven through a flexible coupling by a turbine of 1,570 h.p. Four generators, giving 3,560 volts each, form a group. The receiving station at Lyons will contain six groups of motors coupled to tramway generators. Each group will consist of two motors, each taking 73 amperes at 3,840 volts. In this installation the earth is employed to limit the static voltage of the line, but it does not actually form one of the conductors, except in case of accidental damage, in which case it acts as a reserve line. In this way the cost of the line is practically the same as when the earth is used as the return, while certain useful advantages are obtained. Thus the stray currents are, normally, entirely suppressed, and, in case of breakdown, are reduced by half, whilst another important advantage is the fact that the earth is always available as a reserve line in case one of the conductors fails.

The Cascade Rotary Converter.—A 75 k.w. cascade rotary converter is now being exhibited at the Liege Exposition and has attracted considerable interest. This machine is designed for the transformation of alternating into direct current. It partakes of the characteristics of a motor-generator and of a synchronous converter fed through stationary transformers. The converting equipment is composed of two machines, which may be designated as the input and output machines, respectively. The input machine consists of a rotor and stator, similar to those of an induction motor. The output machine consists of armature and field structures, similar to those of a rotary converter. The rotor of the input machine is mounted on the same shaft with the armature of the output machine, and the rotor (secondary) winding is connected directly to the armature winding.

The operation of the equipment presents numerous points which are well worth mentioning. If it be assumed that the input machine has the same number of poles as the output machine, then the normal speed is equal to just one-half of the speed of the revolving field of the first machine (induction motor). Consider the action of the stator circuits of the input machine. When a certain alternating e.m.f. is impressed upon its terminals, the flux must have a value such that its rate of change produces a counter e.m.f. only slightly less than the impressed. When the primary circuits are symmetrically arranged and subjected to polyphase electromotive forces, the familiar synchronously revolving field is produced. This field cuts across the secondary conductors and generates therein electromotive forces having a frequency proportional to the slip from synchronous speed. The electromotive forces generated in the armature of the output machine, due to its motion through the constant field, will be proportioned directly to the speed. It is evident that these two polyphase electromotive forces will have the same frequency at a certain speed of the rotor, which speed will be one-half of that of the revolving field when the poles of the input and output machines are equal in number.

In comparison with the ordinary rotary converter, the cascade converter possesses the advantage of operating at a lower frequency, and hence its commutation is much better. The input machine can be wound directly for any voltage, and hence stepdown transformers are unnecessary. The makers claim that it it is much lighter and cheaper than a motor-generator set. It is a synchronous machine, but can be started as a simple polyphase induction motor. It supplies its own exciting current, both during the starting period and during normal operation. On the input side its performance is similar in many respects to an induction motor operating at variable slip near synchronous speed, while on its output side it possesses the characteristics of a synchronous converter.

Efficiency of Incandescent Lamps.—Recent tests were made in Paris by Lauriol and Janet for a special purpose of comparing 110-volt and 220-volt incandescent lamps. The results of these tests support the contention that 110-volt lamps are better than 220-volt lamps in point of efficiency (average difference about 20 per cent. in favor of 110-volt lamps), useful life and similarity in illuminating power. After 200 hours the average consumption of the 220-volt lamps tested was 34 per cent. higher than that of the 110-volt lamps. Janet points out, however, that the use of 220-volt lamps is only now becoming common in France and that it would be unfair to form final conclusions as regards 110-volt lamps versus 220-volt lamps from the figures quoted.

New Type of Gas Producer.—In a recent issue of the Zeitschrift des Vereines deutsches Ingenieure, Herr Jahns describes a form of gas producer developed by himself, in which such cheap fuel as bituminous coal, slack and the refuse of screening and washing operations may be used successfully to produce a gas suitable for driving gas engines. The gas is not produced complete in one generator, but passes through a series of four or more, which are interconnected. As gas is being produced, generators are being cut into and out of the series. Each generator is filled full with fuel at the start and no more is added until after it has burnt out. The gas coming from the generator last fired up passes through those already in operation, and thus its quality is fixed, although it contains a high percentage of volatile matter. There is claimed for this type of producer a less cost of production and a more efficient generation of gas.

UTILIZATION OF GAS ENGINES IN CONNECTION WITH LONG DISTANCE ELECTRIC TRANSMISSION.*

By John Martin.

The very rapid progress in the development of electrical machinery and appliances during the past ten years has invited the capitalist and engineer to install and operate many hundred thousand horsepower, utilizing the waters of the various streams as a source for generating the current. The prime incentive for such development from the investor's standpoint was the fact that the source of power was being constantly renewed by the laws of nature, and with the authentic records of precipitation as a guide the prudent engineer has recommended a great many plants to be constructed which have proved financially and commercially successful.

The most notable examples of this progress have been and are being developed in the State of California. A great many surprises of a practical nature have been encountered by the managers of these various water-power electric developments with particular reference to earning capacity, and more particularly with reference to the relation of "plant utility to plant capacity," commonly termed "load factor." The manager is constantly trying to find ways and means of utilizing the electric current during such times of the day or night when his present consumers do not require it. Numerous plans and devices have been utilized to further this end.

Within the past year, the problem was presented to the officers of the California Gas & Electric Corporation, who were desirous of furnishing all the electric current for the operation of the street railroads under the control of the United Railroads of San Francisco, and negotiations were commenced with the officers of the latter company with that end in view. It was very difficult for the railroad people at first to develop even a hope that such a condition of affairs could be made feasible. Here was a company with its thousands of horsepower developed at no point nearer than 140 miles from the proposed place of consumption, and while it is true that this company has many sources of supply and many avenues of delivery, yet there was an insurmountable barrier in the minds of the railroad people as to the advisability of purchasing current at any price if the convenience of its patrons was to be sacrificed in any way. As one of the officers of the railroad company remarked, "We certainly desire to save money in the operation of our property—within reason, but at the same time, we care more for the good will and satisfaction of our patrons, and if any interruption of service should occur on all your lines feeding into this city at one time we cannot expect our citizens to be patient while sitting in the cars for an hour and a half until you get up steam."

The railroads were operating their steam plant for this service, and the power company suggested the continuance of the operation of these steam plants and receive a portion of the power from the power company, but this plan was not considered advisable.

After numerous interviews with an honest desire on both sides to try and accomplish the economic result, if it could be done without sacrificing the interests of the patrons of the railroad company, a firm conclusion was reached that in a service so large and important as the carrying of hundreds of thousands of people daily in a large city, nothing could be done on the plans outlined unless some absolute guarantee of continuity of service were available, and it certainly was not favorable from the standpoint of the utilization of steam engines for emergency purposes, because if steam were being maintained constantly under the boilers, no economy could result, and if the plants were allowed to cool off the time element of starting would prohibit their use.

The officers of the power company had been making thorough investigations of the development of the gas engine in large units, having sent two of their engineers througout the entire East to make full and complete reports. In consequence, and as a last resort, the power company agreed to install three gas engine electric generating units, each unit having a capacity of 4,000 kilowatts, or a total initial capacity of 12,000 kilowatts. This plant will be enlarged as rapidly as the requirements of the railroad may demand.

The guarantees which have been made by the manufacturers of these engines are particularly interesting, electric transmission in a position to practically guarantee continuous service, regardless of the length of its transmission lines or the momentary interruptions which do occur through causes beyond human control. It might be fairly stated that the gas engine stands alone as the only means of instantaneous generation of electric current at distributing centers in times of emergency, at any fair or reasonable cost.

The gas engine electric generating plant of the California Gas & Electric Corporation will also be utilized to a certain extent for the purpose of increasing the load factor of the transmission line, for it is obvious to those familiar with power transmission plants that after proper installations have been made, including full capacity at the hydraulic end, as well as in the power-house, and in pole lines, there is absolutely no increased cost for current to the power company, whether its load factor be .2 or .99, and any device which can be utilized to improve that load factor adds that much income and net profit for the power plant. In this particular case, the gas-engine generating plant was a necessity, for without such the California Gas & Electric Coporation would have been unable to have obtained the contract for power. That being the case, the officers decided to make a virtue out of this necessity, and up to the extent of the cost of fuel being less than the increased value derived from improving the load factor on the power lines, they propose to operate this gas engine plant in that manner and for that purpose.

The gas which will be used to drive these engines will be manufactured from crude oil, and will be of the quality similar to the illuminating gas now being distributed throughout the State of California manufactured by this process, ranging from 610 to 660 B.T.U. horsepower per cubic foot.

Nearly all of the gas engines in use throughout the East and Europe are utilizing producer gas or blast furnace gases, except in very small units or where natural gas can be obtained, and from investigations which I have made I have ascertained that the largest gas engine using manufactured gas of more than 600 B. T. U. horsepower has a rated capacity of 300 horsepower, while those in process of installation near San Francisco will, in each case, be more than seventeen times as large.

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*A paper read before the Thirteenth Annual Meeting of the Pacific Coast Gas [illegible]

The nearest approach to these large engines in size are two which are in operation at Hastings, West Virginia, each having 4500 horsepower capacity, and driven by natural gas, and being used for the compression of natural gas for transmission through a pipe line 200 miles in length. These engines have been and can be started from cold and rest to full load in less than sixty seconds.

The following is a description of these engines: These gas engines are now being built by the Snow Steam Pump Works of Buffalo, N.Y., and in general design and detail resemble very closely a modern high-grade massive American steampower engine. They are of the horizontal, twin tandem, double acting four-cycle type, giving two impulses to each crank per revolution. This is equivalent to a cross compound steam engine. Any cylinder head can be removed from any cylinder by simply disconnecting one jacket water supply pipe and removing the nuts holding the head to the cylinder.

All working parts are above the engine-room floor, nothing but water supply, gas, air inlet and exhaust pipes are below the floor, and these are arranged so that they can be trenched. All the main parts have their proper relative positions positively and permanently fixed by male and female centering fits of large diameter, thus practically insuring self-alignment.

Lubrication of the cylinders is effected by spreading. This is accomplished by leading four oil feeds, fed by individual oil pumps, to each cylinder, and entering the cylinder at points to successfully effect the proper spreading of the oil. The oil is fed to the cylinder on the inhalation stroke, and is spread on the compression stroke, thus being properly lubricated for the power or impulse stroke. The lubrication of journals is effected by means of a positive feed lubricator. Each oil feed is carried to the part to be lubricated by means of small tubing leading from a multiple feed oiler containing a small oil pump for each feed led therefrom. The feed to each part is positive and can be adjusted to give a fixed supply of oil per revolution of the engine. When the engine stops the oil feed stops, and when the engine starts the oil feed also starts. Inlet valves, mixers and cut-off valves will be designed so that gasoline can be injected to the surfaces necessary to be cleaned, rendering the dislodgment of any deposit an easy matter without removing the parts.

The pistons are carried by cross heads, thereby materially reducing the weight carried on the bore of the cylinders. By the use of three cross heads, the main, intermediate and outboard, proper alignment of the pistons is permissible after years of service, and it is questionable whether an engine without this feature can be regarded as entirely satisfactory.

The question of regulation in the generation of electric current by means of direct connected electrical generators has been a problem not only for the gas engine people but for the steam engine manufacturers to solve, and this has been done in the latter case within the last two years practically to the satisfaction of the electrical engineer, so that parallel operation is now successful. The builders of this engine are also following steam practice in this respect, and will be able to keep the angular variation within each revolution at a minimum, satisfactory to the electrical generator manufacturers.

The main shaft will be of the overhung crank type, having the cranks forged with the shaft and with crank pins forced into the cranks. The main connecting rods are simple, plain, with solid adjustable stub ends. The main cross heads are fitted with adjustable babbitted gibs and removable crucible steel wrist pins.

The pistons are designed in such a way that expansion of the faces can take place without affecting in any way the strength or life of the piston. Piston rods extend from the main cross heads clear through the cylinders to the outboard cross heads, and secured to same by nuts. Each cylinder is made in two parts, the joint being circumferential and located half way between the ends.

Separate supply pipes for each individual part to be water jacketed will be furnished, so that the amount of water fed to each part can be regulated, thus permitting the carrying of high temperatures in such parts as cylinder heads, medium temperatures in cylinder jackets, low temperatures to the rods, pistons and metallic packing.

These engines are started by the use of compressed air on storage in compression tanks. Safety devices are provided which carefully control the speed limit.

The dimensions of these engines are very interesting:

Length over all, 70 feet. Width over all, 34 feet.

Weight of heaviest casting, 60 tons.

Diameters of cylinders, 42 inches.

Length of stroke, 60 inches.

Main journals, 30 inches in diameter, 54 inches long.

Main cross head gibs, 27 inches wide, 54 inches long.

Diameter of center of shaft, 38 inches.

Weight of fly-wheel, 130,000 pounds.

Total weight of engine, fly-wheel and generator, 1,200,000 pounds.

These engines will probably be in operation on or before January 1, 1906, and from all the investigations which have been made by my co-workers, we are laboring under no doubt as to the absolute success of this installation when completed.

SPARKS.

Messrs. Hoge & Thompson, who are building a planing mill at Saskatoon, N.W.T., have applied to the Council for a franchise for electric lighting.

Weston, Ont., will continue municipal ownership of their electric light plant for some time at least. Recently the Council rejected the offers of both the Stark Telephone, Light and Power Company, of Toronto Junction, and the Southern Light & Power Company, of Erindale.

Dr. Heroult, of LaPraz, France, inventor of the electric process of ore smelting, is now at Ste. Marie, Ont., in connection with the experiments to be made by the Dominion Government. The furnace has been completed and the experiments will be under way very shortly.

Mr. E. S. Pindell, of Sault Ste. Marie, Mich., has been granted a franchise for electric light and waterworks systems at New Liskeard. The works are estimated to cost $132,000 and the town has agreed to guarantee the bonds to the amount of $80,000.

Mr. F. G. Rumball, president of the Southwestern Traction Company, last month received a cablegram from London, Eng., authorizing the company to proceed with the surveys for an electric railway from London to Hamilton, to be operated in connection with the line from London to Port Stanley. The total mileage will be about 90 miles, involving an outlay of over $2,000,000.

TELEGRAPH and TELEPHONE

WESTERN TELEPHONE EXTENSIONS.

The British Columbia Telephone Company have completed the rebuilding of their long distance line from Laurier, Wash. (on the boundary) to Greenwood, B. C. Cedar poles thirty feet long and not less than 9 inches thick at the top by 14 inches at the butt were used, 35 poles to the mile. The butts were treated with carbolineum to preserve them. The telephone wires are transposed every 1,200 feet and for about four miles, where the line is in close proximity to the Cascade Power Company's high tension line, transpositions are introduced every 600 feet. The work has been carried on under the supervision of Mr. G. C. Hodge, district superintendent. The company expect to soon move into their new building at Nelson, which has just been completed for them.

THE LAYING OF THE LATEST ATLANTIC CABLE.

The Commercial Cable Company's fifth Atlantic cable, from Canso, Nova Scotia, to Waterville, Ireland, was completed and put in operation on October 6th. This makes seven transatlantic cables worked in direct connection with the lines of the Postal Telegraph-Cable Company. All of them are duplexed, so that their combined capacity is 14 messages at one time.

The new cable is described as the best and most expensive submarine cable ever laid. It was manufactured by the Telegraph Construction and Maintenance Company, of London, having been begun in March, 1905, and finished and shipped on board the construction company's steamer Colonia on August 3rd, 1905.

Atlantic cables are always laid from west to east, because the prevailing winds in the summer months on the Atlantic are from the west, and ships meet much better weather going eastward; consequently the Colonia sailed directly from England to America, arriving off the coast of Nova Scotia on August 16th, and landed the heavy shore end of the cable on the morning of August 18th. Moving out from the shore it struck a rock and remained fast thereon for four days. The injuries it sustained compelled it to go into drydock at Halifax with 2,300 miles of submarine cable aboard. It was the largest and heaviest ship ever taken on that drydock, exceeding by thousands of tons the United States battleship Indiana of 10,000 tons, which went into drydock there a couple of years ago. Repairs were made, and the Colonia took the sea again.

On September 23rd the ship laid its course from Canso, N. S., paying out cable. On September 28th it passed through a hurricane in mid-Atlantic, although on that day the weather on both sides of the Atlantic was reported fine, with gentle winds. On October 3rd it arrived without a mishap at a point 187 miles from the coast of Ireland, where a final splice was to be made between the cable that had been paid out from the American side and the 187 miles of cable previously laid westward from the Irish coast by the steamship Cambria in the month of June. The weather was heavy and the Colonia was compelled to heave to for several days awaiting smoother seas to enable it to make the final splice, which was made on October 6th.

At some points the cable was laid at a depth of nearly three miles below the surface of the sea. The quantities used in the manufacture of the cable were 1,411,200 pounds of copper; 799,688 pounds of gutta-percha; 1,500,000 pounds of brass tape, jute yarn, iron wire and preservative compound.

The signaling speed of this cable is reported to be 15 per cent. greater than that of any other cable of equal length in the Atlantic. The cost of the cable varied from $1,000 to $6,000 per mile, according to the character of the ocean bed and depth of water, the great variation in cost being due to the different diameters and weights of the sections of the cable, the cable which is laid in the deepest water being lightest for the important reason that it would be impossible to retrieve a heavy cable from the deep water, because of the enormous pressure. Cable in deep water is practically safe from injury, and therefore does not need to be so strong, so that the sections laid in the deepest water are of smaller diameter and lesser cost. The sections laid near shores are of massive construction and very expensive. In the neighborhood of the fishing grounds off the coast of Newfoundland a type of cable midway between the deep water and shore-end cable is used. The intermediate size is made strong, to resist injuries from the anchors of fishing craft, the most prolific source of danger to submarine cables. This intermediate type is made just heavy enough to afford reasonable prospect of retriving it in the event of its being damaged by the anchor of a fishing vessel.

SHORT-CIRCUITS.

The Winnipeg Board of Trade have decided to agitate for the installation of a municipal telephone system.

A by-law was carried at Port Arthur, Ont., last month providing $18,000 for the extension of the municipal telephone system and central station.

The Bell Telephone Company are arranging to install a telephone system at shoal Lake, Man., to have connection with the long distance service by Hamiota.

Mr. W. J. Duckworth, formerly inspector of the G. N. W. Telegraph Company, has been appointed superintendent of maintenance for the same company.

Mr. F. R. Carney, Ottawa manager of the G. N. W. Telegraph Company, has been promoted to the management of the Montreal office. His successor at Ottawa is Mr. J. G. Davies.

The New Brunswick Telephone Company are making improvements to their exchange at Moncton, N. B. A two storey brick building has been erected and is being thoroughly equipped with modern appliances. The switchboards were obtained from the Kellogg Switchboard Supply Company, of Chicago. Mr. George C. Peters is the local manager at Moncton.

Mr. W. B. Powell, for many years Montreal manager of the Great North-Western Telegraph Company, severed his connection with the company last month, after thirty-seven years' service. He resigned to enter a business life. Previous to his departure he was presented with a beautiful diamond pin as a token of esteem and good will from the staff, including the branch office employees. The presentation was made by Mr. James Tucker. Mr. Powell, in acknowledging the gift, stated that he would prize it very highly as coming from those with whom he had been associated for so many years.

Mr. Beauchamp H. Smith, second vice-president of the S. Morgan Smith Company, of York, Penna, died at his home in Los Angeles on November 1st, at the age of 36 years. Mr. Smith went to Los Angeles about five years ago for the benefit of his health, since which time he has resided there, and hopes of a complete recovery were entertained.

THE REGINA ELECTRIC LIGHT PLANT.

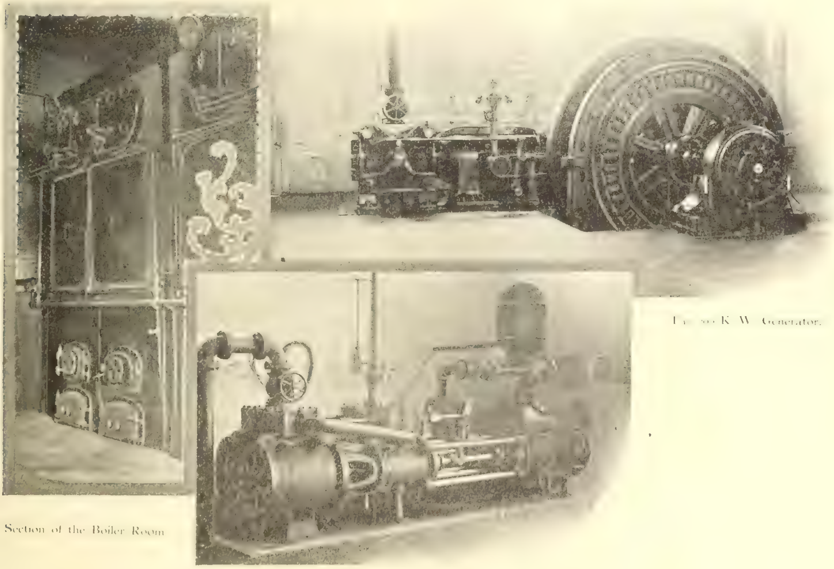
The City of Regina, Saskatchewan, has recently completed modern sewerage, waterworks and electric light systems, from the plans of Mr. John Galt, C. E., of Toronto. The water supply is obtained by gravitation, and by means of the construction of a concrete dam about seven miles from the city, a reservoir with a capacity of 80,000,000 gallons has been formed.

The waterworks and electric light power house is a substantial brick building measuring 70 by 68 feet and situated on the northern outskirts of the city. It is divided into three sections—boiler room, pump room and electric light room. In the boiler room are installed two 250 h.p. Babcock & Wilcox water-tube boilers of the latest design, carrying all the most recent improvements in the water-tube boilers made by that well-known Glasgow firm. The pump room contains the Northey pump, used for increasing the pressure of the water system in the event of fire.

The electric lighting plant consists of a 475 h.p. simple Corliss engine shpplied by the John Inglis Company, of Toronto, connected to a 300 kilowatt generator, manufactured by the Canadian Westinghouse Company and capable of supplying 7,000 16 candle power lights. The lighting system is under the management of Mr. J. A. Johnston, electrical engineer, and is rapidly being extended in all parts of the city. The plant also supplies the current for the 35 arc lamps which make Regina one of the best lighted cities west of Winnipeg.

Waterworks and Electric Light Power House, Regina, Sask.

Mr. J. A. Johnston, Superintendent.


The 300 K W Generator.

Section of the Boiler Room

Steam Pump for Fire Press

Interior Views, Waterworks and Electric Light Power House, Regina, Sask

ENGINEERING and MECHANICS

BOILER INSPECTION IN ONTARIO.

Mr. James T. Burke, Inspector of Factories for Ontario, in his annual report to the Minister of Agriculture, refers at some length to boiler inspection. He says:

Preliminary to a boiler inspection, the boiler, flues, mud-drum, casing, and all connections should be thoroughly cleaned, to facilitate a careful examination. Blisters may occur in the best iron or steel, and their presence, and also that of thin places, is ascertained by going over all parts of the boiler with a hammer. When blisters are discovered, the plates should be repaired or replaced. Repairing a blister consists in cutting out the blistered space and riveting a "hard patch" over the hole on the inside of the boiler, if possible, to avoid forming a pocket for sediment. All seams, heads, and tube ends should be examined for leaks, cracks, corrosions, pitting and grooving, detection of the latter possibly requiring the use of a magnifying glass. Uniform corrosion is a wasting away of the plates, and its depth can be determined only by drilling through the plate and measuring the thickness, afterwards plugging the hole. Pitting is due to a local chemical action, and is readily perceived. Grooving is usually due to buckling of the plates when under pressure, and frequently to the careless use of the sharp calking tool. Seam leaks are generally caused by overheating, and demand careful examination, as there may be cracks under the rivet heads. If such cracks are discovered, the seam should be cut out, and a patch rivetted on. Loose rivets should be carefully looked for, and should be cut out and replaced, if found. Pockets, or bulging, and burns should be looked for in the firebox. The former are not necessarily dangerous, but if there are indications of their increasing, they should be heated and forced back into place or cut out and a patch put on. Burns are due to low water, the presence of scales, or to the continuous action of flames formed on account of air leaking through the brickwork. The burned spots should be cut out and patched as previously described. The conditions of all stays, braces, and their fastenings should be examined, and defective ones replaced. The shell of the boiler should be thoroughly examined externally for evidences of corrosion, which is liable to set in on account of dampness, exposure to weather, leakage, etc., and may be serious. The boiler should be so set that joints and seams are accessible for inspection and should have as little brickwork in contact with it as possible. The brickwork should be in good condition, and not have air holes in it, since they decrease the efficiency of the boiler and are liable to cause injury to the plates by burning, as above explained, and also by unevenly heating and distorting them. The mud-drum and its connections are liable to corrosion, pitting and grooving, and should be examined as carefully as the boiler.

All valves about a boiler should be easy of access, and should be kept clean and working freely. Each boiler should have at least three gauge cocks, properly located, and it is of the utmost importance that they be kept clean and in good order, and the same may be said of the glass water gauge. The middle gauge cock should be at the water level of the boiler, and the other two should be placed one above and one below it, at a distance of about 6 inches.

The conditions of the pumps or injectors should be looked into, to make sure that they are in the best working order. The steam gauge should be tested to ascertain that it indicates correctly, and if it does not it should be corrected. If the hydraulic test is to be used, the boiler should be tested to a pressure of 50 per cent. higher than that at which the safety valve will be set.

EXTERNAL INSPECTION WHEN BOILER IS UNDER STEAM.

The gauge cocks, and also the gauge glass, should be tried, to make sure that they are not choked. The steam gauge should be taken down, if permissible, and tested, and corrected, if necessary. The gauge pointer should move freely. Blowing out the gauge connection will show whether it is clear or not. The boiler connections should be examined for leaks. The safety valve should be lifted from its seat, to make sure that it does not stick from any cause, and it should be seen that the weight is in the right place. Observe from the steam gauge if the valve blows off at the pressure it is set for. See that all pumps and feed apparatus are working properly, and that the blow-off and check valves are in good order. Blisters and bagging may sometimes be detected in the furnace. The condition of the brickwork is of considerable importance, since the existing of air-holes is a source of trouble, as already explained.

Incrustation. One of the chief sources of trouble to the boiler user is that of incrustation. All water is more or less impure; and as the water in the boiler is continuously evaporated, the impurities are left behind as powder or sediment. This collects on the plates forming a scaly deposit, varying in nature from a spongy, friable texture to a hard, stony one. This deposit impedes the transmission of heat from the plates to the water and often causes overheating and injury to the plates. The various impurities in the water may be either in suspension or solution. If the former, the water can be purified by filtration before going into the boiler. If the latter, the substances must be first precipitated and then filtered. Many impurities may be removed by heating the water before feeding it into the boiler. The first thing to do, when dealing with a water supply, is to have an analysis of it made by a competent chemist. The fact that water contains a certain amount of solid matter is no criterion as to its unfitness for boiler use. The presence of certain salts, as carbonate or chloride of sodium, even in large quantities, would not be serious if due attention were given to the blowing off. On the other hand, salts of lime in the above proportion would be very objectionable, requiring greatly increased attention in the matter of purification and blowing off or else cleansing out.

The various methods of dealing with impure water may be classed as follows:

1. Filtration. Where the matter is held in suspension, it can be removed, before the water enters the boiler, by the aid of settling tanks or by filtering, or by forcing the water up through layers of sand, broken brick, etc., or by using filtering cloths in a proper machine.

2. Chemical Treatment. Clark's process combined with a frequent filtration (the joint process being known as the Atkins system), has been successfully applied on small and large scales in the chalk districts of England. Lime water is mixed with the water to be purified, the amount used depending on the composition of the water as determined by a careful analysis. The lime is thus precipitated, and the water is then filtered in a machine containing travelling cotton cloths. Not only is the carbonate of lime entirely removed, but it has been proved that any sulphate of lime that may be present is also prevented from incrusting. This is important, as the latter impurity forms, perhaps, the worst scale one has to contend with.

Various chemical compounds are in use for boilers. Carbonate of soda is perhaps the best general remedy. It forms the basis, in fact, of nearly all boiler compounds, whatever their name or appearance. This soda deals efficaciously both with the carbonate and the sulphate of lime. The precipitates thus thrown down do not form a hard crust; they can be washed out in the form of a sludge or mud.

Carbonate of soda is also useful where condensers are employed, as it counteracts the effect of the grease, which is brought over with the exhaust steam. If used in too large quantities, it will cause priming. The best way to use it is to make a solution of it and connect with the feed, fixing a cock so as to regulate the amount fed in. Soda ashes is much cheaper, but more of it is required, and, besides, it is generally impure. Caustic soda removes lime scale quicker than ordinary soda does, but it is much stronger and liable to attack the plates. It should be used in smaller quantities than the ordinary kind.

Barks, molasses, vinegar, etc., develop acids that attack the plates. Animal and vegetable oils do the same, and also harden the deposits, and make their removal more difficult. It is a good rule to keep all animal and vegetable matter out of boilers altogether.

Feed-Water Heaters. Carbonates and sulphates of lime are precipitated by high temperatures. The heaters should be arranged so that the deposit forms chiefly on a series of plates that can be easily removed for cleaning. If the deposit gathers in pipes, however, it is simply transferring the evil from one vessel to another. A double advantage is gained by these heaters, for the feed water is put into the boiler already heated, and so fuel is saved.

Mechanical Aids. Deposits take place chiefly in sluggish places. Various devices to aid circulation have been brought out. With good attention and a not too impure water, they give satisfactory results.

Potatoes, linseed oil, molasses, etc., are sometimes put into the boiler with the idea of lessening scale formation, by forming a kind of coating around the particles of solid matter and so preventing their adhering together. This certainly takes place, but the substances are injurious, as already pointed out. Whenever a boiler has been cleaned out, we may with advantage give the inside a thin coating of oil, or tallow and black lead ; this arrests the incrustation to a great extent.

Sand, sawdust, etc., are often used, the idea being that their grains act as centres for the gathering together of the solid matter in the water, the resulting small masses not readily collecting together themselves being easily washed out. This may be so, but the cocks, valves, etc., are liable to suffer from the practice.

Kerosene is strongly recommended by some boiler users. There is no doubt that in many cases its use has given good results. It prevents incrustation, by coating the particles of matter with a thin covering of oil, the deposit thus formed being easily blown out. The oil also seems to act on the scale already formed, breaking it up and thus facilitating its removal. As already remarked, it is a good plan, when the boiler is empty, to give the inside a good coating of this oil, afterward putting it in with the feed, the supply being regulated automatically. As to the quantity required, this will be found to vary in different cases, according to the nature of the water; an average of one quart per day for every 100 horse power will give good results in most cases.

In marine boilers, strips of zinc are often suspended; the deposit often settled on them instead of on the boiler plates. Also, any scale that way be formed on the latter is less hard and compact and more easily broken up. Further, any acids formed by the oil and grease brought over from the condenser attack this zinc instead of the boiler plates.

Miscellaneous. Acids are often introduced into boilers to dissolve the scale already formed, the solid matter then being washed out. This treatment should be adopted with great care if at all, as the plates are likely to be affected.

Scale is often loosened and broken up by deliberately inducing sudden expansion or contraction in the boiler. In the former case, the expansion is brought about by blowing off the boiler, and then, when it is quite cooled down, turning on steam at as high a temperature as obtainable, thus causing the scale to expand more quickly than the plates and thus become loose.

In the second method, the boiler is blown off when the steam is at its highest, and a stream of cold water is then turned in. The fires are then drawn, and the fire-hole doors, dampers, etc., opened, letting in a rush of cold air. All this cools the plates, and, by the contraction thus brought about, loosens the scale. These two practices should be guarded against.

Foaming or priming is usually due either to forcing a boiler beyond its capacity for furnishing dry steam, or to the presence of foreign matter. It is dangerous if occurring to any great extent, since water may be carried along with steam into the engine, and a cylinder head knocked out. Foaming when it cannot be checked by the use of the surface blow-out apparatus, may necessitate the emptying of the boiler, which must then be filled with fresh water ; this rids the boiler of the impurities that have collected during the operation of the boiler.

The Fox Bearings, Limited, has been incorporated at Toronto, with a capital of $40,000. It is proposed to acquire the patents for anti-friction bearings owned by Tobias Fox. The directors include Thomas Sullivan and John Nicol, of Pine Glove, Ont.

The Pembroke Electric Light Company have retained the services of Mr. R. S. Kelsch, consulting engineer, Montreal, in connection with the development of their water power on the Black river. The transmission will be fifteen miles. The ultimate development will be for 4,000 horse power; the present installation will consist of one-half the total capacity.

TORONTO ENGINEERS' DINNER.

Toronto No. 1, C.A.S.E., celebrated their nineteenth annual banquet at the Walker House on Thanksgiving Eve, October 25th. It was, as usual, a most enjoyable affair. Covers were laid for 150 guests and every place was occupied. After the abundant repast provided by the genial host, Mr. Thomas M. Bayne, had been partaken of, there was a splendid programme of speech and song. Mr. W. C. McGhie, President of Toronto No. 1, acted as toast-master and discharged his duties in a most acceptable manner. The singing of the National Anthem was the appropriate response to the toast of "His Majesty the King." The respondents to the other toasts were as follows: "Canada Our Home," by Ald. J. H. McGhie; "Our Legislature," by Dr. Beattie Nesbitt, M.P.P., and Ald. S. Alfred Jones; "Educational Interests," by Dr. Pakenham and W. S. Kirkland, of the Technical School, and Mr. Harry Simpson, of the Board of Education; "Manufacturing Interests," by Mr. J. J. Main, of the Canadian Heine Boiler Company, Mr. W. J. Murray, of the Chapman Double Ball Bearing Company, and Mr. J. Litster, of the Pure Gold Manufacturing Company; "The Executive Council," by Messrs. W. A. Sweet, of Hamilton, Charles Moseley and A. M. Wickens; "Sister Societies," by Messrs. J. Ironsides, Hamilton, and J. Fox, Toronto; "The Press," by Messrs. S. Groves, of the Canadian Engineer, A. Bridle, of the Engineering Journal, and T. S. Young, of the Canadian Electrical News; "Toronto No. 1," by Mr. W. McGhie.

Songs were rendered during the evening by Messrs. Medcalf, Wilson, Day and Fletcher. The committee in charge of the arrangements was H. E. Terry (chairman,) W. Tait, (secretary-treasurer), J. W. Marr, G. C. Mooring, Alex. Storer, William Corrigan, William Outhwaite, Charles Birrell and Joseph Hughes. These gentlemen were heartily congratulated on the success which attended their efforts.

GAS ENGINE DRIVEN SINGLE PHASE RAILWAY SYSTEM.

The Westinghouse interests announce the successful starting of the Warren & Jamestown alternating current railway system operating between Warren, Pa., and Jamestown, N. Y. The electrical equipment has had several weeks' preliminary run from a small gas engine driven unit temporarily installed in the power house at Stoneham. On the 19th ultimo the large gas engines were placed in service for the first time and a permanent operating schedule was inaugurated.

Probably the most interesting feature of this rather unique railway system is the exclusive employment of horizontal double acting gas engines of the heavy duty type for the generation of power to operate the road. Two of these engines are now installed, the first of which is already operating. The second will be placed in service in a short time. These two engines will be called upon to operate in parallel on the electrical end. Parallel operation is particularly difficult in service of this kind on account of the violent fluctuations in load which occur, due to the size of the cars employed and the small number in operation at any particular time. As it is not possible to utilize storage batteries to absorb these fluctuations, the engines are called upon to sustain them and are thus put to the severest possible test occurring in the operation of electric power plants.

The two units installed are each of approximately 500 b. h. p. capacity direct connected to 260 kw. revolving field engine type single phase generators. Each has two cylinders arranged in tandem fashion with a single crank. They will operate entirely upon natural gas distributed by a local company. In this district the gas has a calorific value of 1,000 b.t.u. per cu. ft. A 55 h.p. vertical Westinghouse engine of the single acting type is also in operation driving air compressor and exciting unit for the main equipment.

Current is generated directly at a voltage suitable for transmission without the use of transformers. Transformer substations are located along the right of way which reduce the line voltage to 3,300 volts for the trolley, at which pressure it is collected by the cars.

The Warren & Jamestown Street Railway, although recently organized upon its present basis, has been running part of its present line for eleven years. Three years ago it began experimenting with gas power with sufficient success to induce the use of gas engines for the entire power generation. The successful starting of the power system will be accepted with general gratification, and will mark an important advance in modern electric railroading.

PERSONAL.

Mr. John Bell, of Winnipeg, has been appointed electrician for the corporation of Indian Head, N.W.T.

The School of Practical Science have awarded a fellowship in electrical engineering to Mr. R. H. Armour.

Mr. C. B. King, of Detroit, has been offered and accepted the management of the London Street Railway Company, London, Ont., as successor to Mr. C. E. A. Carr.

Mr. Zavitz, late of the Toronto office of Allis-Chalmers-Bullock, has been placed in charge of their Vancouver office. Mr. Murphy, of the Winnipeg office, who has been temporarily in charge at Vancouver, has returned to the Prairie Capital.

Mr. A. Bruce Smith, recently appointed manager of telegraphs for the Grand Trunk Pacific Railway, entered upon his new position on November 1st. Before leaving Toronto he was presented with a handsome solid silver tea service by his old friends of the G.N.W. Telegraph Company.

Mr. Angus MacDonald has been appointed chief electrician in charge of the electrical equipment of the LeRoi Mines at Rossland, B.C., to succeed Mr. S. F. Crawford, who has removed to Korea. Mr. MacDonald was formerly with the electrical department of the Canadian Smelting Works at Trail, B.C.

Mr. Seth B. Smith, formerly with the Westinghouse Electric and Manufacturing Company, Pittsburg, in charge of their Los Angeles, Cal., branch, has been placed in charge of the Canadian Westinghouse Company's Vancouver branch. Mr. Smith has had a wide and varied experience in matters electrical during the past twenty years, a large part of which time has been spent with the Westinghouse Company.

Mr. S. F. Crawford, for the past three years chief electrician of the LeRoi Mines at Rossland, B. C., has been appointed chief electrician in charge of the electrical plant of the Oriental Consolidated Mining Company, of Korea. Mr. Crawford was formerly with the Jones & Moore Electric Company and the United Electric Company, both of Toronto. He is now in Toronto bidding adieu to old friends and expects to sail from Vancouver early in December. The mines to which he is going are located in the Yalu River within 40 miles of Port Arthur. A 6,000 h.p. electric plant has been installed for mining purposes, the product being gold and copper ore. The ELECTRICAL NEWS wishes Mr. Crawford success in his new field of labor.

Major Joly de Lotbiniere, son of Sir Henri Joly de Lotbiniere, Lieutenant-Governor of British Columbia, recently returned to England after a visit to Canada. Major Joly is noted as one of the foremost English civil and electrical engineers. He has planned and surpervised the installation of a number of large electrical plants and irrigation systems, a commission which he is now executing being an immense irrigation and power scheme which is being carried out by the Indian Government near Kashmir. Four large rivers are being dammed and a huge lake formed to store water which will irrigate over ten thousand acres of splendid rice lands. This stored water will also be utilized to generate over 100,000 horse power in electrical energy, which will be used as power for rice and flour mills and other purposes. Major Joly inspected nearly all the large water power plants on the Pacific coast, including that of the Vancouver Power Company.

The corporation of Fraserville, Que., recently purchased an electric light plant. Mr. John Hogg, electrical engineer, is now engaged in putting the system in first-class condition.

Application will be made to Parliament at its next session to incorporate the Buffalo, Niagara and Toronto Railway Company, with power to construct an electric railroad from Niagara-on-the-Lake to St. Catharines and Port Colborne, and touching Fort Erie.

The Town Council of Ingersoll, Ont., at a meeting held on October 17th, decided to enter into a new contract for street lighting with the Ingersoll Electric Light and Power Company, the latter to supply ten arc lamps of 2,000 candle power all night for 300 nights a year for $1,000. Mayor Boles has refused to sign the contract, to which there is much opposition owing to the fact that 25 arc lights have been cut off under the new arrangement. Since the original tenders were opened, the Electric Light Company have offered to furnish an all-night service with 45 arc lights for $2,500 per year, the present contract price for 37 arcs, of which only ten burn all night.

PUBLICATIONS.

Kindly mention the CANADIAN ELECTRICAL NEWS when writing for any of the catalogues referred to below.

The latest bulletin from the National Electric Company, Milwaukee, Wis., relates to their new belt-driven alternating current generators.

We have been favored with a copy of the charter of the Niagara-Welland Power Company as amended to 1905, with a chronological table of events. The president of this company is Mr. Harry Symons, K.C., Toronto.

The Mines Branch of the Department of Interior, Ottawa, have issued a very valuable report on "Mica, Its Occurrence, Exploitation and Uses," the author being Mr. Fritz Cirkel, M.E., of Montreal. The book consists of 150 pages and is profusely illustrated.

Engine Bulletin No. 3, issued last month by the Goldie & McCulloch Company, Galt, Ont., describes their heavy duty Corliss engine. One of the illustrations is a 17 x 30 inch Goldie Corliss engine direct connected to a 150 k.w. alternating current generator installed for the corporation of East Toronto.

The Westinghouse Companies' Publishing Department have compiled a small folder for the storage battery department of the Westinghouse Machine Company. It is entitled "Westinghouse Storage Batteries for Railway Service" and serves as an announcement of this new and important branch of their business.

"Westinghouse Railway Apparatus" is the title of an attractive booklet which came to hand last month from the Canadian Westinghouse Company, Hamilton, Ont. It illustrates and describes their direct current railway motors, single phase alternating current motors, Baldwin-Westinghouse electric locomotives and the Westinghouse systems of control.

A neat booklet from the Industrial Engineering Company of America, 32 Broadway, New York, calls attention to their facilities for assisting manufacturers. They are specialists in designing electric motors, individual electric driving of machinery and tools, and furnish complete drawings and specifications for power and manufacturing plants of every description.

Managers and operators of electric plants will find much information regarding rotary converters in a book of 70 pages recently issued by the Westinghouse Electric & Manufacturing Company, of Pittsburg. Instructions are given for starting a single converter with a starting motor and from direct current side, and to start a second converter to run in parellel with another, also what to do when the circuit breaker comes out.

The Pittsburgh Transformer Company have published a book on "Thawing Frozen Water Pipes by Electricity." In this book are a large number of letters from the managers of various electric light plants and waterworks which used the standard thawing outfit that the Pittsburgh Transformer Company placed upon the market last winter. The Pittsburgh Transformer Company state that in addition to the large number of thawing outfits which they shipped to all parts of the country by freight last winter, they also shipped approximately twenty tons of thawers by express. A number of purchasers delayed placing their orders until late in the season, thus rendering express shipping necessary, with its attendant high charges. The company recommend that this year orders be placed in good season so that freight shipments can be made, thus saving considerable expense.

At a meeting of the board of directors of the American Institute of Electrical Engineers held September 26, 1902, a resolution was passed appointing a committee of five members for the purpose of collecting data respecting present practise in electric transmission at high voltage and to present a report which would indicate the successful methods which are now in operation in such form as to be of immediate value to electrical engineers. The information gathered by this committee was given to the members in a series of papers presented at the meetings of the Institute. These, with the subsequent discussions thereon, have been published in book form by the McGraw Publishing Company, of New York, under the title of "High Tension Power Transmission," the contributors to which are Ralph D. Mershon, F. O. Blackwell, P. M. Lincoln, C. C. Chesney, C. L. Cory and A. M. Hunt. The price of the book is $3.

The dissolution is announced of W. J. O'Leary & Company electrical contractors, Montreal.

SPARKS.

Chicago capitalists have been examining the Bull River Power Company's works near Cranbrook, B.C., with a view of carrying the enterprise to completion in the near future.

It is reported that T. H. Smallman and other local capitalists have secured an option on the London street railway, London, Ont. The road is now controlled by Messrs. Everett and Moore, of Cleveland.

A by-law will be submitted to the ratepayers of Owen Sound, Ont., at the January elections to provide $25,000 for extending the municipal electric light plant. When the plant was purchased by the corporation about three years ago, there were only 1,500 lights, now there are 8,500. The number of meters in use has increased from 36 to 432.

The city of Nelson, B.C., has acquired a water power site on the south shore of the Kootenay river at Upper Bonnington Falls, directly across from the new plant of the West Kootenay Power & Light Company, where they intend to erect a municipal electric plant which will ultimately have a capacity of 5,000 horse power. Their present plant is entirely inadequate to supply the needs of the city and the new plant is therefore a necessity if the city wishes to retain control of the supply of electricity used in Nelson. The new plant is to be divided into four units of 1,250 h.p. each. The power house superstructure is designed to be 28½ feet wide by 102 feet long. For the present, however, it will only be about 60 feet long, sufficient to accommodate two units, which will comprise the initial installation. A 750 k.w., 12,000 volt, 60 cycle, three phase A. C. Bullock generator of the revolving field type will be used. They will generate at 12,000 volts and dispense with step-up transformers. Aluminum wire will be used for transmission. The water wheels used are Esher-Wyss vertical turbines, operating under a head of 60 feet at low water. The city of Nelson has been operating its own electric plant, supplying the commercial lighting for the city since 1898, and the new plant is being built to meet the increased demand and also enable the city to offer cheap power for manufacturing purposes.

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The Barber Electric Company, of Vancouver, B.C., are moving to more spacious quarters on Howe street.

Engineer Patrick, of the Department of Public Works, Winnipeg, will report on the prospects of utilizing the Bird Tail river at Birtle, Man., for power purposes.

The announcement is made that the Great Falls Power Company will proceed at once with the development of 50,000 electrical horse power for transmission to Winnipeg. All the details of construction have not yet been worked out, but it is understood that the company will install at the falls 10,000 h. p. units. Power will be delivered in Winnipeg by January 1, 1907. The floatation of the bonds of the company to the amount of $6,000,000 has been undertaken by Mr. H. M. Byllesley, of Chicago.

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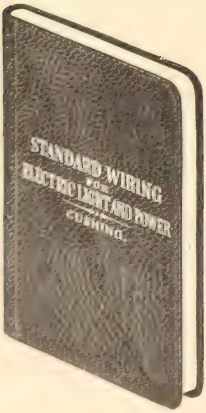

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SPARKS.

It is reported that the machinery at the asbestos quarries near Richmond, Que., will shortly be operated by electric power transmitted from Shawinigan Falls.

Mr. John Galt, C. E., of Toronto, has submitted a report to the Town Council of Fort Francis, Ont., on the installation of waterworks and electric light plants, the latter to be operated in conjunction with the pumping station.

The Dominion Coal Company are understood to have placed a large order for electrical apparatus with the Canadian Westinghouse Company. The contract calls for three generators of 500 k.w. each, twelve motors and 89 transformers.

A company is being formed in London, Ont., for the purpose of generating electric power. The site of the proposed plant is on the Thames river a short distance below Kilworth and within eight miles of the city. At thls point the river has a heavy fall. Mr. J. M. McEvoy, of London, is solicitor for the company.

The Federal Electric Construction Company, Limited, has been incorporated, with a capital stock of $40,000 and head office at Brantford, Ont. The charter gives the company power to manufacture and deal in dynamos, motors and other electrical apparatus. The provisional directors are John Ellis, of the Township of York, and G. H. Kilmer and W. H. Irving, of Toronto.

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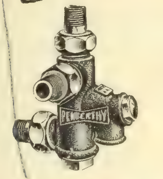

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The Town Council of Welland, Ont., are considering the purchase of the electric light plant now owned by Mr. Page.

The City of Winnipeg Power Association has been incorporated, with a capital of $100,000, to develop and transmit electric power and to construct all necessary works for this purpose. The promoters include Messrs. J. H. Ashdown, wholesale merchant, and John Arbuthnot, lumber merchant.

An Ontario charter has been granted to the Electric Meter & Stamping Company, Limited, of Toronto, with a capital stock of $200,000. It is proposed to manufacture and deal in electric, water and gas meters and electrical supplies generally. The directors are Messrs. Anthony Krane, William Bullock, John Creighton, F. Sinclair and George Kerwin.

Owing to the death of Mr. C.E. Stephens, the firm of Stephens & Hawkins, electrical engineers and contractors, Victoria, B.C., has been succeeded by Hawkins & Hayward, who will continue the business at 95 Fort street.

There has recently been constructed, at Revelstoke, in connection with the electric lighting plant, what is probably the largest wooden-stave flume in Canada. This pipe is eight feet in diameter and 320 feet long and was manufactured by the Canadian Pipe Company, Vancouver. It is intended to extend the pipe the full length of the flume, 1,600 feet, to entirely replace the square box-flume at present in use. The electric plant itself is also receiving attention, a new 26-in. Samson turbine water wheel having been installed, also a new 120 Kw. single phase, 2,300 volt C. G. E. generator.

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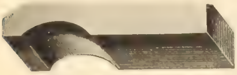

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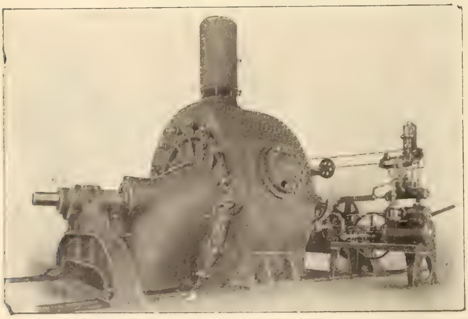

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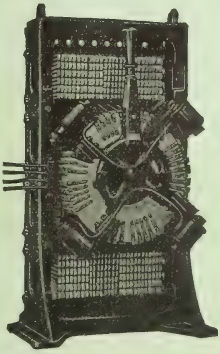

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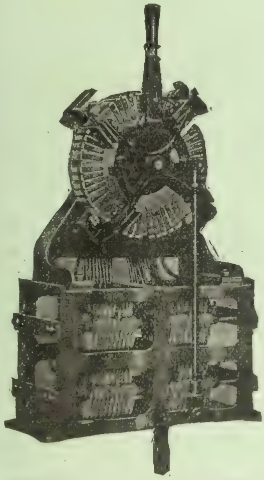

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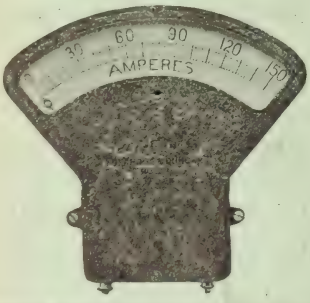

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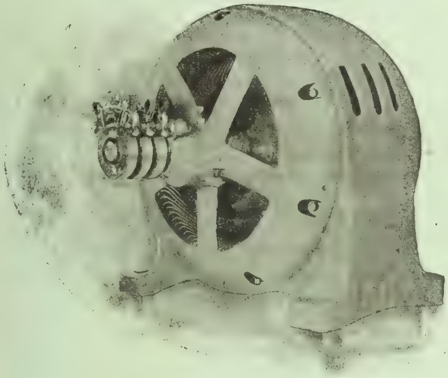

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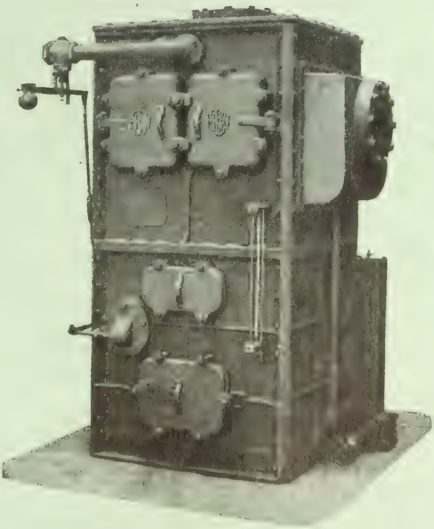

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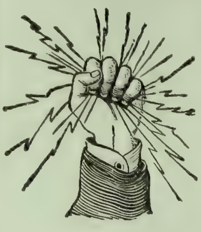
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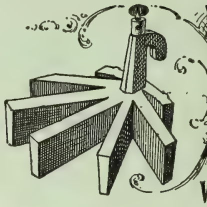
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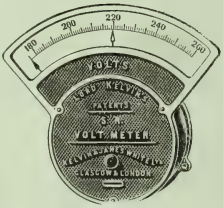

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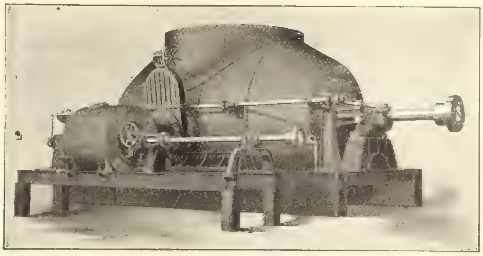

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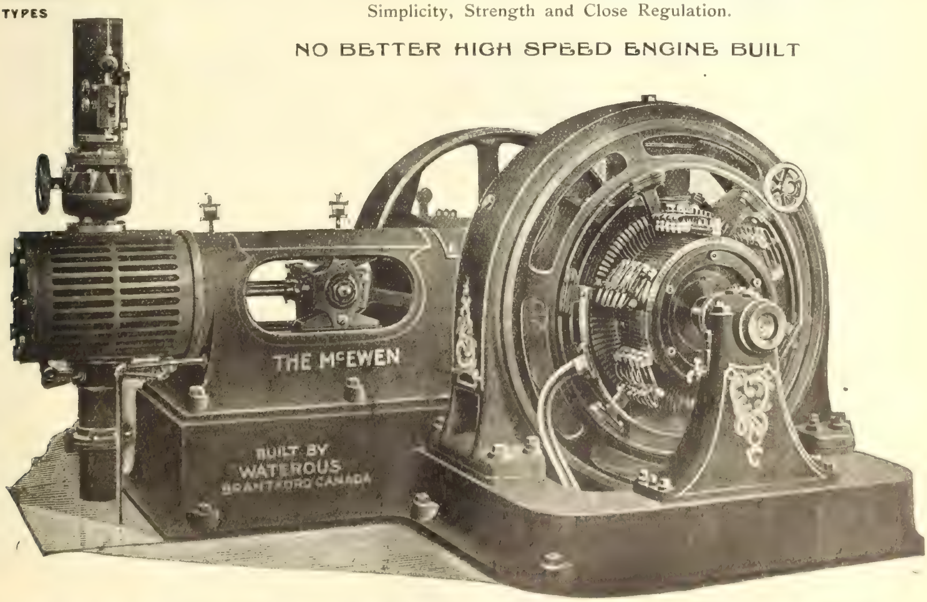

WATEROUS, BRANTFORD, CANADA

SPARKS.

The Russell Electric & Hydraulic Company, Limited, has been formed at Sydney, N.S., Mr. W.H. Russell being president and Mr. F. Tingle vice-president.

Mr. A.B.W. Hodges, superintendent of the Granby Company, Phoenix, B.C., has placed an order with the Canadian Westinghouse Company for a 250 h.p. electric motor, to be used for hoisting purposes.

The Western Counties Power Company have renewed their application for a franchise from the city of Brantford, Ont. They claim that they can effect a considerable saving in the cost of lighting the city.

It is probable that a by-law will be submitted to the ratepayers of Pictou, N.S., to raise the sum of $8,000 for the purpose of installing a duplicate engine and generator for the electric light plant.

The directors of the Montreal Street Railway Company have decided to appropriate the sum of $1,000,000 for new equipment, etc. About half of this amount will be expended immediately in new cars and new feed lines, while the balance will go into new sub-stations, machinery, etc. The above sum is in addition to all extensions and alterations which may be made to the tracks.

A special committee on electric lighting has reported to the Town Council of Uxbridge, Ont., recommending that no action be taken at present in regard to the purchase of the plant, but that a committee interview the owners with a view to having the arc lamps changed to an incandescent system and improvements made in the system generally.

It has been rumored during the past month that the Brantford Street Railway is likely to change hands and that extensive improvements are contemplated. The statement has also been made recently that the Southwestern Traction Company intend building an electric radial road through Western Ontario and connecting Brantford and London.

Mr. J. Shipton, of Vancouver B. C., is forming a company to install an electric light plant at Ladner, a progressive town in the Fraser River valley.

Messrs. D. Graham & Sons Co. have recently sold their electric lighting business at Inglewood, Ont., to Messrs. Stevens & Nediker.

The Cartierville Electric Light & Power Company have secured a 25-year franchise for the lighting of the town of Bordeaux. The same company have also the contract for furnishing light and power to the town of St. Laurent, Que. Mr. Charles Brandeis, C.E., of Montreal, is the consulting engineer.

The Woodstock Electric Railway, Light and Power Company, of Woodstock, N.B., have bought out the Small & Fisher electric light business and have laid out a considerable amount of money in developing electrical power for lighting and power. They are building a dam 400 feet long, 125 feet wide and 30 feet high, which will be completed this month. They have installed two pairs of 21 inch Crocker wheels, which they purchased from the Jenckes Machine Company, of Sherbrooke, and also two 200 kilowatt generators from the Canadian General Electric Company.

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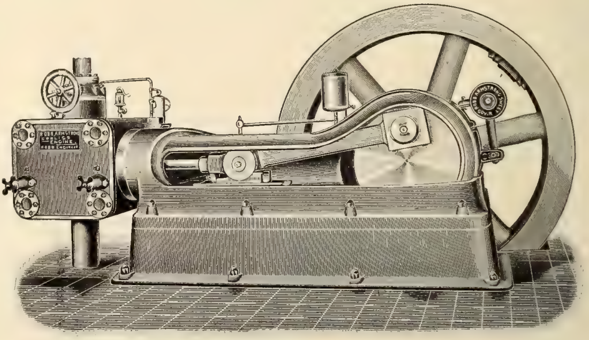

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SPARKS.

The ninth general meeting of the British Columbia Electric Railway Company, Vancouver, B.C., was held in London, Eng., on October 16th. The reports submitted were very satisfactory.

Mr. J. B. McRae, C. E., of Ottawa, has been engaged by the Town Council of Orillia to prepare plans for a new dam to be constructed at Ragged Rapids in connection with the electric light plant.

The Fire and Light Committee have recommended that the Town Council of Harriston, Ont., give to Mr. George Leighton another five years' contract for lighting the streets, at a cost of $1,100 per year.

The Ontario Power Company have a contract to supply the town of Niagara Falls, Ont., with 1,000 horse power at 2,200 volts, and will therefore install transformers to step down the current from 12,000 volts

The Armstrong Power and Light Company, Armstrong, B.C., has been organized, the intention being to install an electric light and power plant on Davis Creek. A by-law has been prepared and will be submitted to the ratepayers for ratification. It provides that work must be commenced within 12 months.

The British Columbia Electric Railway Company, of Vancouver, B. C., last month awarded contracts for further extending their generating and distributing plants. The Canadian Westinghouse Company were given the contract for an alternating current generator, to be connected to a Pelton water wheel. It is proposed to lay another pipe line from the dam to the power house, and it is probable that the improvements will mean an expenditure of $125,000.

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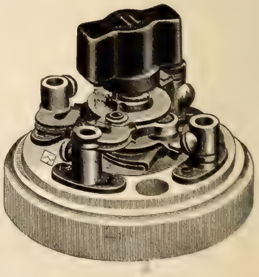

SPARKS.

The Canadian Westinghouse Company are understood to have secured the contract for equipping twenty-five new cars for the Montreal Street Railway.

The City Electric Company, of Calgary, Alberta, have opened up new offices and show rooms on the corner of First street west and Twelfth avenue. They carry a full line of electrical fixtures and supplies, motors, etc. The company consists of Messrs. G. Hawford and W. J. Halliday. They desire to receive catalogues and prices from wholesale supply firms.

The tenth commemoration of Founder's Day of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N.Y., was observed with appropriate exercises in the Assembly Hall of the school on November 30th. The address was delivered by Mr. John Cassan Wait, a member of the American Society of Civil Engineers and an attorney and counsellor at law of the City of New York.

The Shawinigan Water & Power Company have just awarded to the Westinghouse Company the contract for a second 12,000 h.p. generator to be installed in their power house Shawinigan Falls, Que. It is understood that the new generator will be used largely for supplying power throughout the mining districts in the province, and particularly those relating to the production of asbestos. Some of the additional power however, will be transmitted to Montreal.

The Carleton electric light plant at St. John, N. B., has been purchased by the St. John Railway Company, this being the outcome, evidently, of the threatened invasion of the city of St. John by the former company. It is understood that the purchase price was between $12,000 and $15,000. Electric lighting on the west side of St. John was originated about 1885, when the firm of D. C. Clarke & Son secured a contract for the street lighting. In course of time the franchise was transferred to the Carleton Electric Light & Power Company.

The Edmonton Electric Light and Pumping Station, Edmonton, Alberta, started on November first to run a 24 hour service instead of only nightly, as hitherto. As a result there is quite a demand for electric elevators and hoists in many of the higher buildings in the city, nearly all this year's new buildings of three or more stories being equipped with elevators. Electricity for lighting is also becoming more and more used. The Northwest Electric Company have wired the jail for about 200 lights, the new Merchants' Bank building, the Empire Block, McDougal & Secord's new building and the C.N.R. station.

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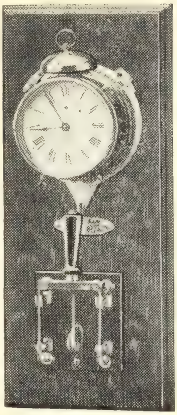

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MONTREAL ST. CATHARINES WINNIPEG

SPARKS-

Mr. T. A. Burrows, M.P., is taking steps to establish an electric light plant at Grandview, Man.

The Nipissing Foundry Company are installing an electric plant to light their shops at North Bay, Ont.

The Council of Strathcona, Alberta, are taking tenders on the supply of a new engine for the electric light plant.

A private lighting plant is being installed in the Cornwall Cotton Mills, St. John, N. B., electricity replacing gas.

The Tavistock Milling Company, Tavistock, Ont., are installing an electric light plant in their mill, to be operated by a Tree rotary engine.

The Council of Carberry, Man., are considering a pfoposition for the establishment of an electric plant for street and commercial lighting.

The ratepayers of Bobcaygeon, Ont., will vote on a by-law at the January elections to provide $25,000 for the purchase of a water power from Boyd Bros.

The Toronto Railway Company are installing the Cora automatic fender on some of their cars. This fender is the invention of Mr. F. N. Campbell.

The Huron & Ontario Electric Railway Company, which secured a charter from the Ontario Government some years ago, have had surveys made for an electric railway from Meaford to Owen Sound.

The Berry Lubricator & Machine Company, Limited, Ottawa, Ont., has been incorporated, with a capital stock of $250,000, to manufacture an automatic journal lubricator, the invention of Mr. Austin Berry, of the Township of Sheppard, Que.

The St. John Street Railway Company have recently added to their snow-fighting equipment a large wing plough, which will throw off all the snow within 12 feet of the track, and a McGuire Cummings sweeper, which will clean both sides of the track.

A proposal has been made to the City Council of Winnipeg that an issue of bonds be put on the market to raise money to cover the expenditures of the electrical department, which have heretofore been provided for in the annual estimates. A new power house will soon be required.

The British Columbia Electric Railway Company have decided to make large extensions to their system and will carry their lines into the adjacent farming districts. It is expected that hay cutters, cream separators, etc., will be operated by electric power.

The Renaud Interlocking & Block System Company, Limited, Montreal, has recently been incorporated, with a capital stock of $250,000, to manufacture a system of automatic signals and brakes to stop railway coaches. Messrs. Ernest Renaud, mechanical engineer, and Albert Dupuis, electrical engineer, Montreal, are members of the company.

The Corporation of Bracebridge, Ont., has just taken tenders on the supply of one pair of horizontal water wheels, penstock, draft tube, flume, etc. ; one exciter wheel, with case, draft tube, and gate valves ; one 300 k.w. a. c. 2,000 volt, two-phase generator ; one exciter, and one marble switchboard. Mr. John Thompson is the Chairman of the Light & Water Committee.

The new power house at Glace Bay, N.S., is now practically completed. It is a brick building 75 x 42 feet, with corrugated galvanized iron roof. It has a steel concrete smokestack 105 feet in height and built by the Weber Steel & Concrete Company, Chicago. The Robb Engineering Company, of Amherst, have installed Robb-Armstrong Corliss engines and Robb-Mumford boilers, the generators being supplied by the Canadian General Electric Company. It is expected that the plant will be in operation this month.

The Ontario Government has issued a charter to the Northumberland-Durham Power Company, Limited, of Cobourg, Ont., the object of which is to develop the Healy Falls power for electrical purposes at Campbellford, Cobourg, Port Hope, Brighton, and other places. The capital stock of the company is $750,000, and the provisional directors include Messrs. W. J. Crossen, president of the Crossen Car Company, Cobourg ; J. A. Culverwell, Port Hope ; Charles Donnelly, of Pittsburg; Samuel Nesbitt, Reeve of Brighton, and others.

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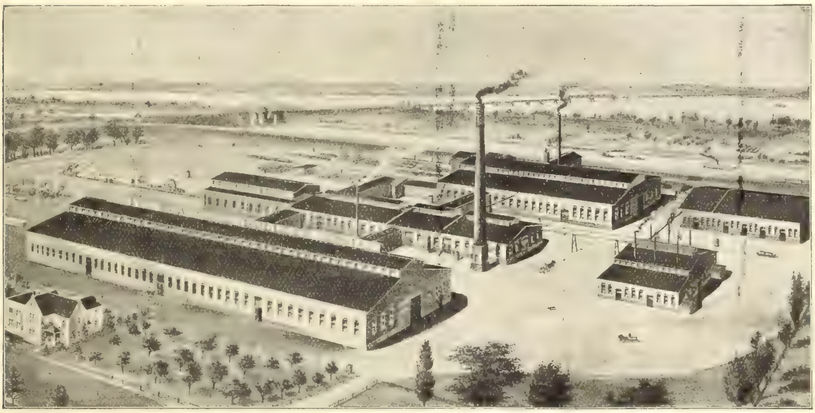

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- Small Bipolar and Multipolar Motors and Generators.

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BRANCH OFFICES : HALIFAX, TORONTO, WINNIPEG, NELSON, VANCOUVER

SPARKS.

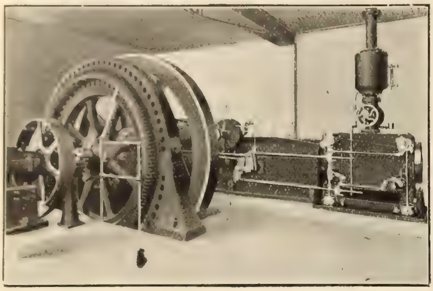
The North Bay Heat, Light & Power Company, North Bay, Ont., have installed a new engine and dynamo.

The Electric light plant at Revelstoke, B.C., is being enlarged. In future meters will be used instead of the flat rate system.

The City Council of Ottawa have decided to have the recently acquired electric light plant managed by a commission of three, including the Mayor.

The Council of New Liskeard, Ont., have decided to discontinue negotiations with private parties for waterworks and electric light systems and to take steps toward the installation of services under municipal ownership.

According to the terms of the contract between the Montreal Light Heat and Power Company and the city of Montreal, the price of electric street lighting from January 1, 1906, will be $60 a year. At the present time Montreal has 1,455 arc lamps, ninety 65 c.p. lamps, 310 32-c.p. lamps and 380 gas jets. The Montreal Light, Heat & Power Company are constantly making improvements to their system, and with the additional lights to be installed at an early date, there is reason to believe that the lighting of the city will afford the citizens the highest degree of satisfaction.



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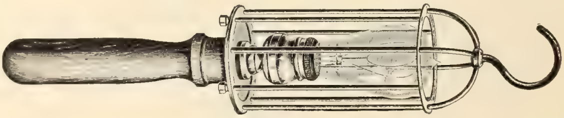
The ALPHA PORTABLE LAMP GUARD

Strong. Durable. Ornamental.



The **Alpha Portable Lamp Guard** is especially adapted for use in Machine Shops, Engine and Boiler Rooms, Bank Vaults, Basements, and, in fact, anywhere where it is desirable to carry an incandescent lamp short distances.

Its construction is such that while it is strong enough to stand the hard usage of a Boiler Room, it is sufficiently ornamental for offices. Complete with socket and cord.

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PROGRESS OF THE ALUMINUM INDUSTRY.

During the year 1904 the Pittsburg Reduction Company improved its plants at New Kensington, Pa.; Niagara Falls, N.Y.; East St. Louis, Ill.; Bauxite, Ark., and Shawinigan Falls, Quebec. The prosperity in the aluminum industry has been shared also by the Royal Aluminum Company, Shawinigan Falls, Quebec, Canada; the British Aluminium Company, with works at Foyers, Scotland; the Societe Electro-Metallurgique Francaise of LePraz, Savoy, France; the Compagnie des Produits Chimiques d'Alais of St. Michel, Savoy, France, and the Aluminum-Industrie-Aktien - Gesellschaft of Neuhausen, Switzerland; Rheinfelden, Baden, Germany; and Lend Gestein, near Salzburg, Austria.

The processes employed are the Hall in the United States and Canada, the Hall and Minet and the Heroult in France, and the Heroult in Switzerland, Germany, and Austria. A departure of some interest is the attempt to utilize the extensive deposits of bauxite at Leece, Italy, and the water falls of Pescara to generate electric power for the purpose of manufacturing aluminum. It is understood that Italian and German capital has become interested in this new enterprise.

ELECTRIC BAKING.

It is stated in the Electrical World that electricity bakes 1 lb. of bread with a consumption of 3·685 k.w.-hours in the plant of the Natural Food Co. at Niagara Falls. To bake the same weight of bread in an oven heated by combustion the company uses 0·3306 lb. of anthracite coal, costing about 0·0687c. The factory is 466 ft. long by 66 ft. wide and four and five storeys in height. The electric energy used for lighting, power and baking comes from the plant of the Niagara Falls Power Co., about 3,500 ft. distant, in the form of a two-phase 25-cycle 2,200-volt current, and is received in 18 transformers. Four of these transformers, rated at 75 k.w. each, deliver current for incandescent lighting at 115 volts. Four of 150 k.w. each supply 440-volt current to induction motors and a rotary converter. For the electric ovens there are 10 transformers of 140 k.w. capacity each. Two of them are required for each oven. Machinery throughout the plant is driven by 87 induction motors, ranging from 1 h.p. to 40 h.p., and aggregating 560 h.p. Some parts of the factory operate day and night, and the load from about 6:30 p.m. to 6:30 a.m. remains nearly constant at 210 k.w. Within an hour after 6:30 in the morning the load rises to more than 700 k.w., and, with the exception of a drop during the noon hour, ranges from that figure to more than 800 k.w. until about 5 p.m. After that time it falls in an irregular way to the minimum of 210 k.w. Perhaps the single operation that consumes more power than any other is that of shredding the wheat. From the shredder the wheat drops on to an endless belt, and is carried to the electric oven, or else goes to the cutter, and is divided into biscuit for the oven that is heated by combustion. One of the electric ovens for baking the shredded wheat in the form called triscuit turns out about 2,483 triscuits per hour, weighing 77·6 lb. Energy consumption in the electric oven varied a little, but was some 286 k.w. on an average, this figure including all transformer losses.

Thawing

Frozen Pipes.

THE OLD WAY: Send for the plumber and his confederates; build fires upon the frozen ground; dig up lawns and streets; dirty mess until cleaned up properly in Spring; bill of $25 to $100.

THE NEW WAY: Send for the Electric Light people who set their Pittsburgh 1905 Thawer, turn on current and water flows in five minutes; no digging, no delay, no trouble and bill only a few dollars.

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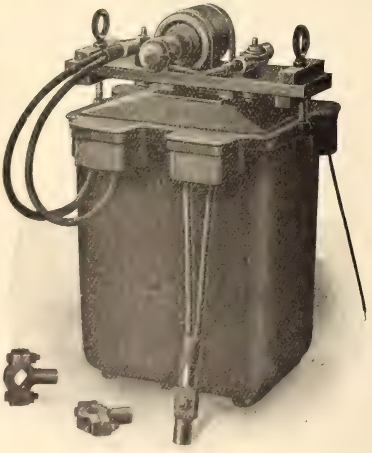

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CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL

Vol. XV. DECEMBER, 1905 No. 12.

Electric Power Plant of the Lakefield Portland Cement Company.

On the 1st of January, 1901, the Lakefield Portland Cement Company, located at Lakefield, in Peterboro County, commenced the manufacture of Portland cement. This company being the first in Canada to use electric power to operate cement works, a description of their plant may be of interest to readers of the Electrical News.

Lakefield is favorably situated on a branch line of the Grand Trunk Railway ten miles from Peterboro and on the route of the Trent Valley waterway, which affords many good water powers throughout its course.

POWER PLANT AT YOUNG'S POINT.

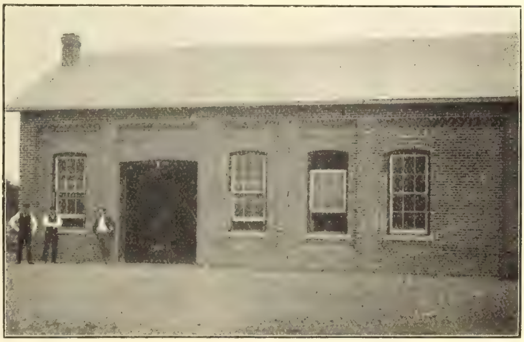


Fig. 1.—Power House at Young's Point.

The site selected for the first power plant is Young's Point, which is situated at the foot of Clear Lake and Stoney Lake, which afford a reservoir of many square miles. The fall from Clear Lake to the Otonabee river gives a head of seven feet normal, which although a low head is reliable, as the reservoir of lakes afford a steady power. Work on the power plant was commenced in the fall of 1899 and completed in November, 1900. Upon the removal of an old saw mill which occupied the site the excavation was made for the setting of four large turbine wheels. Plans for the hydraulic work were designed by Mr. A. B. McCallum, C.E., of Peterboro, which called for concrete construction. The flumes are 20 feet 9 inch wide by 7 feet high. The turbine installation consists of four right-hand 68 inch Sampson turbines manufactured and installed by the Wm. Hamilton Manufacturing Company, of Peterboro. These wheels are set in open flume, working under a head of seven feet, and capable of developing 680 h.p. at a speed of 63 revolutions per minute.

The turbine shafts are 7½ inches in diameter, and the lay shaft, which is made in five sections, is seven inches in diameter at large end and five inches at outer end. These wheels are geared to run the generator at a speed of 200 revolutions per minute. For three years these wheels have been in service twenty-four hours daily and have given every satisfaction.

THE GENERATING EQUIPMENT.

The power house, shown in Fig. 1, is a solid red brick building 25 feet by 30 feet, with galvanized sheet iron roofing, in which is installed the electrical equipment. The generator (Fig. 2) is a C.G.E. three-phase revolving armature type, 400 k.w., 550 volt, 60 cycles, at 200 r.p.m. direct connected to the lay shaft. The exciter is of the multipolar type, and has a rating of 12.5 k. w. at 125 volts. It is belt-driven from the main shaft. Provision is made for an additional generator of 150 k.w. capacity, belt-driven from the main shaft.

The low-tension switchboard is of blue Vermont marble and is located on the west side of the building. It is made up of three panels 6 feet 8 inches by 2 feet 6 inches; the center is the generator panel and is equipped with ammeter, voltmeter, three single-pole bus-bar quick-break knife switches, with marble barriers, generator field rheostat and generator non-arcing field switch. The panel to the left is the transformer panel, equipped with three double-pole quick-break knife switches with marble barriers, and a three-pole knife switch for fan motor. The panel to the right is the exciter panel and is equipped with voltmeter, ammeter, generator, series field switch, station light switch and exciter rheostat. Each panel is supplied with two pilot lights.

Three single phase step-up transformers of the air cooled type, rated at 135 k.w. each, are mounted on a raised platform at the south end of the building. They receive generated current at 550 volts, which is stepped up to 11,620 volts for transmission to Lakefield. The transformers are supplied with cold air at ⅜ oz. pressure from a blower fan manufactured by the Buffalo

Forge Company and driven by a 2 h.p. 550 volt induction motor.

The high tension switchboard is mounted on the same platform directly in front of the transformers. The panel is 7 ft. 6 in. × 3 ft. of blue Vermont marble and equipped with six single pole quick-break high tension knife switches, each protected from possible arc by marble barriers. The arrangement of switches on the high tension and low tension switchboards permit the cutting out of any one of the three transformers in the event of a burn out or becoming otherwise disabled.

Arranged on the ceiling over the transformers are three banks of lightning arresters, each bank having five arresters connected in series.

All low tension wiring is carried in glazed tile pipes with cemented joints placed beneath the floor.

The entire electrical equipment, including the pole line, was supplied and installed by the Canadian General Electric Company.

THE TRANSMISSION LINE.

The transmission line between the generating station and Lakefield a distance of five and one-half miles, is supported on cedar poles spaced 100 feet apart. Each pole has a single cross arm 4 in. × 4 in. of Georgia pine, with steel braces and Locke porcelain insulators on locust pins. The conductors, three in number, of No. 6 medium hard drawn copper wire, are carried on the one four pin cross arm, two on one side of the pole, spaced 13 in. apart, and one on the other side spaced 18 in. from centre conductor. A barb wire fastened on the top of the poles is grounded at every fifth pole to a steel plate buried five feet in ground. The ground wire passing from the plate to the barb wire is enclosed in a length of ⅜ in. gas pipe from the plate to a height of 9 feet above the ground to protect it from injury.

The transmission line has two transpositions placed so that the line is of three equal divisions. There is also a telephone circuit of two No. 12 medium hard drawn copper wires supported on a two pin cross arm placed 6 feet below the transmission line and transposed every fifth pole.

The poles vary in length from 30 to 50 feet and the line runs along the highway to within a mile of the works, where it follows the company's railway track to the sub-station.

POWER PLANT AT LOCKS NO. 3.

In the summer of 1902 the directors of the company, having been assured of the success of their business, decided to double their output from 500 to 1000 barrels daily. To carry out their plans more power would be required to operate the additional machinery, and the development of another power was decided upon. The site selected was at Locks No. 3, Lakefield division, Trent Valley Canal, being 2½ miles south-east of Lakefield and seven and one-half miles from Peterboro. In September, 1902, work was commenced on the power plant as designed by Mr. A.B. McCallum, C.E., of the Wm. Hamilton Manufacturing Company, Peterboro, under the supervision of Mr. T. E. Wade, of Peterboro. The design for the hydraulic work is in many respects similar to that at Young's Point for a four wheel turbine setting. Fig. 3 shows a view of the power house, concrete flumes, dam and glance pier in river below.

HYDRAULIC CONSTRUCTION.

The excavation for the wheel pits and tail race was carried on with rock drills operated by steam, the work being commenced at the south end and deepened towards the wheel pits to a depth of 11 feet under the arch. The entire masonry structure, including the floors of the penstocks, which are reinforced with 10 inch steel I beams, is of concrete construction, composed of gravel, cement and rough stone removed from excavation in the proportion of five parts gravel to one of cement. The cement was of the Company's own manufacture, 2,300 barrels being used in the work. Suitable gravel was obtained on the ground. As the necessity for early completion required that all the masonry be put in place during the winter, steam coils were placed on the top of the concrete at night, covered with heavy tapaulin supported by boards across the moulds. In this way only two days were lost by severe weather througout the masonry work.

The work of keeping the water out of the excavation was effected by placing, temporarily, two water wheels arranged in one of the openings of the dam. Power was transmitted by shafting and belting to one 10-inch and one 6-inch rotary pumps, which kept the wheel pit dry throughout the work.

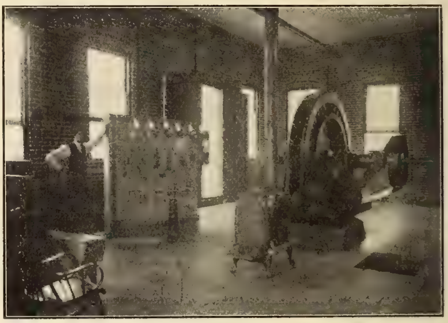


Fig. 2.—Interior of Power House at Young's Point, Showing 400 K. W., C. G. E. Generator.

Following the completion of the penstocks, work was commenced on the power house, which stands on a concrete masonry foundation 40 ft. x 50 ft. to a height of 15 ft. from the solid rock, the walls of which are 5 feet wide at the base and 3½ feet at top. The pier for the generator built at the same time is 14 feet x 18 feet at base, 11 feet x 15 feet at top, and 12 feet high. The building, which is a handsome one, is of cut limestone. The stone was selected from the wheel pit excavation, while the arches, sills and chimney are built of concrete blocks. The walls are 22 inches built to a height of 22 feet above the concrete foundation. The wood sheathed galvanized sheet iron roof is supported on three heavy timber trusses. The floor is of concrete and the walls are of rough cast cement plaster. The building is equipped with a ten-ton travelling crane manufactured and installed by the Wm. Hamilton Manufacturing Company, Peterboro'.

As in the plant at Young's Point, the water wheels in this installation are of the Samson type and were also installed and manufactured by the Wm. Hamilton Company. There are four 68 inch wheels, two right and two left hand, working under a 12 foot head and running 83 revolutions per minute. They are set vertically in open penstocks 13 feet 6 inches wide, are direct connected to the generator and are geared to run same at a speed of 200 revolutions. The wheels are temporarily governed by a type O Lombard governor. A vertical governor type N of the same make will shortly be installed. The exciter unit consists of one 23 inch Samson wheel also set vertically in open flume. The vertical shaft is 7½ inches in diameter for large wheels, and vertical gate shafts is 2⅜ inches diameter. The lay shaft over wheels is 8 inches at large end and 6 inches at outer end. These wheels are capable of developing 1,550 horse power under 12 foot head.

THE ELECTRICAL EQUIPMENT.

The electrical equipment was manufactured and installed by the Dick, Kerr Company, of Preston, England, through their Canadian representatives, Messrs. Campbell & Renton, of Kingston. The plant is designed to operate in parallel with Youngs Point power without step-up transformers. The generator, a view of which is shown in Fig. 4, is a three-phase revolving field type machine having a rated capacity of 1,000 k.w., 11,500 volts, 60 cycles at 200 revolutions per minute, direct-connected. The exciter is of the multipolar type, has a rating of 20 k.w., 100 volts at 500 revolutions per minute, and is also direct-connected.

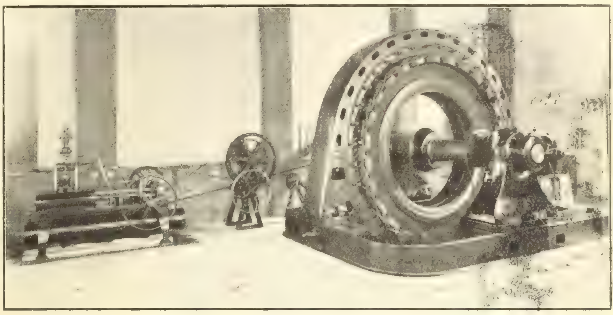


Fig. 4. Generator in Power House at Locks No. 3, Showing 1000 K. W. Dick-Kerr Generator.

The switchboard is of white Italian marble 7 ft. 6 in. × 3 ft. 6 in.; made in four sections, two for generator and two for exciter. The generator panels are equipped with synchronizing lamps, pilot lamps, three ampere meters operated by series current transformers, voltmeter sealed to read direct, power factor indicator, generator field rheostat synchronizing lamp, switch and spring switch for electrical release of oil switch. Two double pole double throw switches are provided for voltage readings across any phase through potential transformers with a ratio of 100 to 1 The high voltage oil switch is operated by a long handle lever mounted on switchboard; it is also provided with electrical release. Two colored lamps, red and green, are automatically lighted, indicating the position of the switch. On separate section of generator panel is mounted the generator field switch with choke coil attachment.

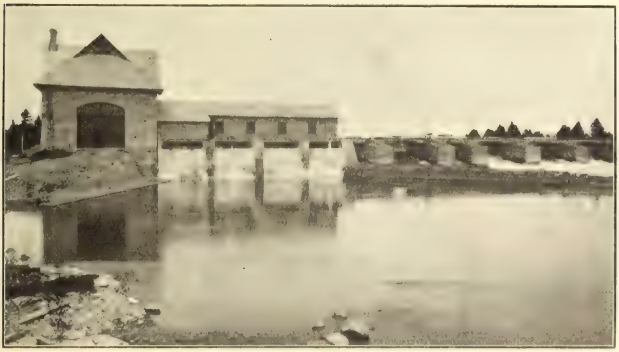


Fig. 3. Power House, Concrete Flumes, Dam and Glance Pier at Lock No. 3.

The exciter panel is equipped with pilot lamps, ammeter and voltmeter of the Weston type, double pole 200 amp. quick break main switch, and on separate section the field rheostat.

On an arm to the right of the switchboard, supported by the high voltage bus-bar supports, is attached a direct reading electro-static three-phase ground detector of the C.G.E. type, reading from 0 to 12,000 volts.

In the pit below the switchboard, connected in series with the leads from the generator to the oil switch, are mounted on high voltage insulators three choke coils of the Westinghouse type rated at 75 amperes on 12,000 volts. Junction boxes are also here placed, and in the generator pit connecting the high voltage rubber-insulated cables with the lead sheathed paper-insulated cables.

The lightning arresters for the line are mounted on the wall directly over the high voltage bus-bars and in rear of line feeders. They are of the C.G.E. type arranged in three banks, connected four in series. On the outer wall of the building is a projecting shelter in which is installed three lightning arresters with choke coils attached manufactured by Jng. A. Gola & Company, of Italy.

The leads from the generator to the switchboard are laid in duct beneath the concrete floor and are 100,000 c.m. paper insulated lead sheathed cables tested to 25,000 volts. The bus-bar and outgoing feeders are of single conductor No. 2 B.W.G. covered with half black and half white rubber one-half inch thick, covered with a triple braid and compounded, and manufactured by the British Insulated Wire Company.

THE TRANSMISSION LINE.

The transmission line between the generating station and Lakefield is supported on cedar poles placed 110 feet apart. Each pole has a single four pin cross-arm 4" x 4", with steel braces and Locke porcelain insulators mounted on ½ in. steel pins fitted with wooden thread for insulator and porcelain base through which the pin passes, a nut and washer on the pin holding it in place in the cross-arm. The conductors, three in number, of No. 2 B. & S. hard drawn copper wire, are carried two on one side of pole, spaced 11 in. apart, and one on other side spaced 16 in. from center wire. On the top of the poles, supported on glass insulators, is run a barb wire grounded at every fifth pole. There is also a telephone circuit of two No. 10 B.W.G. galvanized iron wires supported on a smaller cross-arm placed 7 ft. below and transposed every second pole. The poles vary in length from 30 ft. to 45 ft. being set a profile, avoiding all abrupt changes in level.

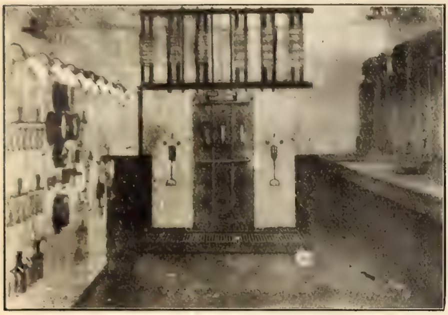


Fig. 5.—Interior of Sub-Station at Lakefield.

The line runs partly on government reserve close to the river and partly on private right of way to a point within 300 yards of the sub-station before crossing the river. The river at this point being 300 feet, crossing was effected by raising a pole in a pier about one-third the distance. After crossing the river the line is met by the Young's Point line about 500 feet from the sub-station; from this point the two power lines are run to the sub-station on the same poles and cross-arms, one line on each side of the pole.

THE SUB-STATION.

The sub-station and synchronous motor room adjoin each other and are situated on the west side of the main building and about 75 feet from the G.T.R. tracks. The sub-station, 24 ft. x 35 ft., is of limestone construction, with wood sheathed roof covered with tar compound and concrete floor. The power lines on entering the building at the south end are carried on high voltage insulators to two 11000 volt oil switches of the same type and make as at No. 3 power house.

The high voltage switchboard is located directly in front of the oil switches. It has three panels, the one to the right and left being oil switch panels on which are mounted the levers for operating the switches, also the colored lamps to indicate the position of the switches. The center panel has mounted on it six single pole high voltage quick-break knife switches with marble barriers. The three at the top are connected to No. 3 power line and the synchronous motor circuit, and the three at the bottom to Young's Point power line and the synchronous motor circuit. Each oil switch connects its power line with the transformer high voltage bus bars. With this arrangement of switches either power plant may operate the synchronous motor load while the other operates the transformer load, or they may be connected in parallel.

Mounted on the wall above the high voltage switchboard are the banks of lightning arresters for each line which are of the C.G.E. type referred to at Young's Point and No. 3.

On the west side of the station on a raised platform over the air duct are mounted six C.G.E. air cooled type transformers of 135 k.w. capacity each, receiving current at 11,000 volts and transforming down to 575 volts. The air duct through which the cold air passes for the transformers is of concrete construction 3 feet by 3 feet by 24 feet. Cold air is supplied by a blower fan, manufactured by the Buffalo Forge Company, at ⅜ oz. pressure, driven by a two horse power 575 volt induction motor.

The low tension switchboard is 7 ft. x 14 ft., made up of five panels of blue Vermont marble, as shown in Fig. 5. The centre panel is the instrument panel on which are mounted three ammeters of the Westinghouse type reading from 0 to 1,600 amperes and operated by series current transformers. The voltmeter is of the C. G. E. incline coil type, which by means of a plug switch reads the voltage across any phase. There is also an electro static ground detector of the C. G. E. type also supplied with plug switch for testing lines to ground. The two panels to the right are transformer panels, three transformers being operated from each. Mounted on each panel are three double pole 200 ampere quick-break knife switches with marble barriers and one double pole knife switch for each lighting transformer. On one of the panels a three pole knife switch is provided for fan motor. The two panels to the left are feeder panels for the motor circuits; six 200 ampere triple pole quick-break knife switches are mounted on one panel, while the other panel has space for three switches, one of which is in place. Each panel is supplied with two pilot lamps.

Two C.G.E. type 15 k.w. oil cooled transformers, transforming current from 575 volts to a three-wire secondary at 230 and 115 volts, supply current for 30 C.G.E. enclosed arc lamps and 350 incandescent lamps.

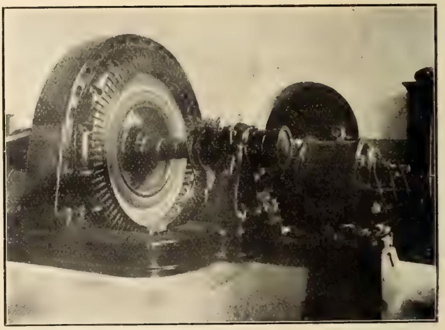


Fig. 6.—600 H. P. Synchronous Motor and Starting Motor.

The motor room adjoining the sub-station is 22 ft. x 28 ft. in which is installed the synchronous motor shown in Fig. 6. This motor was manufactured and installed by the Dick Kerr Company, of Preston, England. It is a three phase, 11,000 volt, 600 h.p., 60 cycle motor, direct connected to a line of shaft from which is driven seven grinding mills for finishing cement. The 50 h.p. starting motor is a Brown Boveri wound rotor variable speed type, motor operating on 575 volts and is geared to the synchronous motor as seen in Fig. 6. The exciter is of the Dick Kerr multipolar type, is belt driven from the motor shaft and is rated at 12 k.w. at 100 volts.

The switchboard is of white Italian marble 2½ ft. × 7 ft. and has mounted on it synchronizing lamps, pilot lamp, voltmeter, ammeter, exciter ammeter, multiple voltmeter, switch, spring switch for electrical release of oil switch, operating lever for high voltage oil switch, exciter rheostat and exciter main switch.

In the motor pit and the pit below the switchboard are in place the choke coils and junction boxes the same as referred to at Locks No. 3 power plant. The wiring is all of the same make and arrangement as described in connection with the power plant at No. 3.

There are connected to the various machinery throughout the works four 100 h.p., five 50 h.p., one 15 h.p. and two 10 h.p. induction motors of the C. G. E. type.

As a result of the continued increase in the Company's business, a second works was built the past summer, bringing up their daily capacity to 1,500 barrels and in all probability next year will see the daily output increased to 2,000 barrels.

Mr. E. W. Bailey, Chief Electrician.

PERSONNEL.

The company employ a staff of six electricians. Mr. E. W. Bailey, their chief electrician, has been with the company since its inception. He commenced his electrical career with the Royal Electric Company sixteen years ago, having since been connected with light and power plants at Arnprior, Hawkesbury, Perth, Stanstead and Ottawa.

The Lakefield Portland Cement Company is a Canadian company, the directors being Mr. J. M. Kilbourn, president ; Mr. R. P. Butchart, vice-president ; Mr. W. H. E. Bravender, second vice-president ; Mr. A. S. Butchart, superintendent, and Mr. F. H. Kilbourn, secretary-treasurer ; Mr. H.B. Smith. To the untiring energy and devotion of the president and superintendent is largely due the success which has attended the launching of this enterprise.

We are permitted to publish this description through the kindness of Mr. E. W. Bailey.

NEW HYDRO-ELECTRIC PLANT.

As previously announced, the West Kootenay Power & Light Company, Rossland, B. C., are at present constructing a hydro-electric power plant at the Upper Bonnington falls on the Kootenay river. The capacity of the new plant is to be 20,000 horse power, under a head of 70 feet. The water wheels to be used will be of the vertical type, having a capacity of 8,500 h. p. The generators will be the Canadian General Electric Company's revolving type, revolving field, 3-phase, 60 cycles, 2,200 volt, capacity 4,500 k.w.

The current will be stepped up to a line pressure of 60,000 volts, and transmitted over an eighty mile transmission line to Rossland,. Grand Forks, Phoenix and Greenwood. There are two pole lines, each of three 85,000 circular mills, hard drawn bare copper cables. At the different points mentioned, the company are erecting sub-stations, each having the necessary transformers for reducing the line voltage to that required for local distribution.

In addition to this new development, the West Kootenay Power & Light Company at present own and operate a hydro-electric power plant at Lower Bonnington Falls, having a capacity of 5,000 h.p. This plant has been in operation since 1898 and delivers power and light to Nelson, Trail and Rossland. The power is transmitted at a line pressure of 2,000 volts to these different points over a duplicate pole line 31 miles long. This old plant will be run as an auxiliary to the new 20,000 h.p. plant on the Upper Falls, making a total capacity of 25,000 h. p. available for commercial purposes.

The whole line in connection with the new development runs through a mountainous country which has not heretofore been opened up, other than by trails. Since the construction of this new power line, wagon roads have been built by the West Kootenay Company which makes the country accessible for that kind of transportation. Along one of the pole lines they have placed a telephone line of No. 8 hard drawn bare copper wire extending the entire distance. This telephone line connects all the company's sub-stations en route between the generating station and the terminus of the transmission line.

Starting at Grand Forks, the West Kootenay Power & Light Company will supply power to the Granby Smelter there, to the Granby Mines at Phoenix, and to the B. C. Copper Company's Smelter at Greenwood. The new plant is expected to be completed, in every respect, by the first of March next, and ready for operations. It is expected, however, that power will be delivered to the Boundary Country by the first of December.

PERSONAL.

Mr. W. Phillips, manager of the Winnipeg Street Railway, was in Toronto recently attending the funeral of his father.

Mr. C. H. Hines, formerly electrical engineer for the C.P.R., has been appointed master mechanic and chief engineer of the Tezuitlan Copper Company, Tezuitlan, Mexico.

Mr. F. Griffith, superintendent of the Hamilton Street Railway, has been appointed to a position in the office of the Cataract Power, Light & Traction Company, and has been succeeded by Mr. D. N. Miller, assistant superintendent.

Mr. K. B. Thornton, operating manager for J. G. White & Company, electrical engineers and contractors, New York, has been appointed manager of the Nassau Light & Power Company, Rosyln, N.Y., which company is managed and operated by J. G. White & Company.

GAS ENGINES WITH ORDINARY CITY GAS.

The economy of the gas engine when used under proper conditions is well established. It has, however, a number of drawbacks. It requires very careful adjustment and constant skilled supervision. It is not economically adapted to large range of load and has practically no overload capacity. It requires a much larger water supply than an equivalent non-condensing steam plant.

To install gas engines on ordinary commercial manufactured gas, fulfilling the legal requirments in candle power and purity, is at best a doubtful experiment. An instance ot this is a description and record of a test of a municipal gas engine electric power generating station which will here follow.

The station contains four Westinghouse three cylinder gas engines on one side and two Bullock electric generators on the opposite side belted respectively to an intermediate countershaft.

Engines Nos. 1, 2 and 3 are each of 125 rated brake h.p., 13″ diameter cylinders, with 14″ stroke and normal speed 265 revolutions. Engine No. 4 is 85 rated brake h.p., 11″ diameter cylinder, 12″ stroke, 285 normal revolutions. The engines were guaranteed to give one brake h. p. hour on consumption of 12000 British thermal units (B.T.U.) in gas, and require a gas of not much under 600 B. T. U. per cubic foot for their proper working. With 600 B. T. U. gas the requirment is 20 cubic feet of gas per h.p. hour, and with lower B. T. U. gas the consumption is correspondingly greater.

The generators are alike, each being of two bearing type, normal speed 500 revolutions, normal voltage 240 and capacity 200 k.w., with overload capacity up to 75 per cent. momentarily and less for longer periods and efficiency ranging from 85 per cent. at quarter load to 92½ per cent. at full normal load. The positive pole of one and the negative pole of the other connect each to an outer wire No. 0000, and the other poles negative and positive respectively connect to the centre, neutral, wire, No. 00 of a three wire transmission system. This enables the giving of 500 volt (the generators being regularly run at 250 V. and over) current between the two outer wires and 250 volt from either outer to the centre wire as is required for motors and lighting respectively. There was no spare generator in the way of provision for emergency and the generators had to run continuously from Sunday evening until Sunday morning.

The countershaft, 4 in. in diameter, is 48 ft. long subtending the position ot the four gas engines. A centre Dodge friction clutch divides it into two parts, the south part carrying the two dynamo pulleys, one clutch pulley each for engines 1 and 2 and a pulley for driving a small igniter dynamo ; and the north part clutch pulleys for engines 3 and 4 and a small pulley driving the air pump for the engine air compressor tanks. The countershaft had insufficient support. The bearings and their support standards were too light and spaced too far. One bearing was eliminated by reason of error in fit of shafting on foundations. The belting had fair drive length, 24 ft. and 26 ft. between shaft centres respectively, from engines and from generators to countershaft, and was of double leather, ample for available power, of good quality and well put on except at engine No. 3, on which the belt to countershaft was much too tight.

The total engine rated capacity was 460 brake h.p., with no overload permissible. Assuming 15 per cent. transmission loss, which is small considering the flexible countershaft, and an inadequate assumption for less than the full engine loads, the total is reduced to 391 h.p. as applied to the dynamos where a further translation loss depending on percentage of actual to rated full load occurs. The normal full load of the dynamos is 400 k.w. With 92.5 per cent. efficiency this would require $535 \times \frac{100}{85} = 630$ h.p. as equivalent engine capacity. Considering the overload capacity of the dynamo the engine capacity shows less than half ot the required equivalent.

A well put up marble switch-board with summation voltmeter and separate ammeters, one on each of the outer transmission wires, completed the station equipment. There was no recording wattmeter and none available.

The load varied during the twenty-four hours from about 15 to 120 k.w., being fairly steady from 7 a.m. until noon at about 50 k.w., again from noon until 6 p.m. at 30 to 40 k.w., and heaviest during early evening. Consumption is in street lighting, incandescent lighting, and power supply for motors in light manufacturing, etc., the latter being the bulk of the day load. The four engines and countershaft were designed for the fluctuating load, the engines acting separately or together. The tests were made in a summer month with no overlapping of day load and heavy lighting load.

The tests were on actual performance and were mostly made during regular operation of the plant. The measure of work done was taken at the switchboard. Cylinder pressure indicators are of use with gas engines for valve regulation only and friction brake tests would on the whole not have given much more of the required information than the determinations made. Observations were made first with load on, then for short times with load off, generators off, and countershafting off, the engine running free on loose pulley only ; with engines separately and in combination. While the tests were not exhaustive in that full-load performance of engines was not obtained, and of generators could not nearly be obtained, and definite losses due to countershaft and belting were not determined, they were closely indicative of the efficiency of the plant as a whole.

Observations were made as follows :

Time readings were taken for every 100 ft. of gas consumed.

B.T.U. value of the gas was determined every ten minutes.

Voltmeter and ammeter readings were taken by two observers, every five minutes.

On speed of engines, ot countershaft and of generators.

The gas used throughout was coal gas from the Town supply and was made by the ordinary retort, distillation process. It was measured by a water chamber meter. The B.T.U. values were determined by means of a Juncker calorimeter. All instruments used were verified from standards. The water used during the tests could not at the time be measured, but it was closely approximated from measurements before and after. The consumption during the regular twenty-four hour run of the station at the time was from 36,000 to 38,000 Imperial gallons.

TABLE 1.—TESTS UNDER LOAD.

Time.	K.W. output at Switchboard.	Rate of Gas Consumption.		B. T. U. of Gas.	Remarks.
		Cub. ft. per hour.	Cub. ft. per k.w. hour.		
2 p.m.	28.8				Engine 2.
2.10	30.2	2000	37.6		
2.20	28.2	"	26.6	588	
2.30	29.4	"	37.8	580	
2.40	28.7	"	38.8		
2.50	30.5	'	37.1		
3	34.2	"	32.6	615	
3.10	32.3	1880	32.3	591	
3.20	36 3	2000	30.6	585	
3.30	34.2	"	32.6	578	
3.40	27	2120	43.6	575	Engine 3. Shaft Speed 320 Engine Speed 255 Dynamo Speed 500
3 50	32.8	2000	33.9	578	
4	27.5	1850	37.3	587	
4.10	28			585	
4.20	29.2	1900	36.2	587	
4.30	26.6	1870	39.2	581	
4.40	20.5	1500	40.5	590	
4.50	28.3	2000	39 2	589	
5	29.6	1720	32.2		
5.10	34.8	2000	31.7		
5.20	30.9	"	36		
5.30	26.4	2065	41.6		
5.40	29.2	2000	38.1		
5.50	25.4	1840	40.2		
8	100.5			578	Engines 2 and 3. Shaft Speed 316 Dynamo Speed 496
8.10	113.	5000	24.6	579	
8.20	116.1	4300	20.6	579	
8.30	116.1	5000	24	579	
8.40	118.2	"	23.1		
8.50	121.1	"	22.9	579	
9	117.4	"	23.6	583	
9.10	111.2	"	25.	583	
9 20	112.1	6000	29.6		
9.30	103.2				
10 a.m.	38.3	2300	33.4	593	Engine 2. Shaft Speed 324 Dynamo Speed 508
10 10	41.9	"	30.6	590	
10.20	38.8	"	33.2	590	
10.30	43.2	"	29.6	598	
10.40	43.2	"	29.6	600	
10.50	41.9	2140	28.4	"	
11	44.6	2500	31.2	605	
11.10	44.6	2302	28.8	610	
11.20	43.6	2500	31.7	605	
11.30	39.9	"	34.8	610	
11.40	37.8	2302	34	602	
11.50	35.1	"	36.4	"	
12	25.2	2000	44.5	600	

TABLE 2.

Engines.	a	b	c	d
1.	1,330 (V. 552)	1,200	1,000	857
2.	925 (V. 545)	750 to 800	857	800
3.	1,500 (V. 533)	1,100 to 1,200	1,043	850 to 1,000
4.	857 (V. 545)	800	631 to 666	546

a Rate of gas consumed, cub. ft. per hour, dynamos and voltmeter on, no load.

b Rate of gas consumed, cub. ft. per hour, dynamos on, voltmeter off, no load.

c Rates of gas consumed, cub. ft. per hour, countershaft on, dyn. belts off.

d Rate of gas consumed, cub. ft. per hour, engine on loose pulleys on shaft.

TABLE 3.

Time.	Engine.	Output at Switchboard. K. W.	Per cent. of Capacity of Generators.	Rate of gas consumed. cub. ft. per hr.
7 A.M.	3	18 9	4.2	2,300
8		40.5	9	2,200
9		51.3	11.4	2,400
10		51.3	11.4	2,300
11		51.3	11.4	2,300
12	2	18.9	4.2	2,300
1 P. M.		32.7	7.3	1,100
2		32.7	7.3	1,600
3		38.1	8.4	2,200
4		35.4	7.9	2,100
5		35.4	7.9	2,200
6		24.5	5.5	2,100
7		24.5	5.5	1,600
8	2, 3	109	24.2	3,200
9		114.4	25.4	5,000
10		95.3	21.2	4,200
11		73.5	16.3	4,400
12		64.4	14.3	3,600
1 A. M.		59.4	13.2	4,100
2		61	13.5	3,000
3	1, 2	59.9	13.3	3,500
4		59.9	13.3	3,500
5		27.5	6.1	3,300
6		13.7	3	1,400

The results of the tests are shown in Tables 1 and 2. The B.T.U. average of all tests was 590, minimum 575, maximum 610. Hourly observations on load output and gas consumption were continued for about a month. The average daily rate of output varied very little, and was about 49.5 k.w. per hour with a consumption of 65,000 cub. ft. of gas for the twenty-four hours. This reduces to 41.5 cub. ft. of gas per average h.p. hour as measured at the switch-board. Table 3 gives record for an average twenty-four hour day.

The cost of the gas at the time was high, figuring 60½ cents per thousand cub. ft. for materials and labor, made up as follows: Coal less coke 37.1, labor 19.3, purifying and plant maintenance 4.1. This exceptionally high cost was due to the bad condition of the retorts used at the time and the fact that the candle power had to be maintained by the coal gas alone, cutting off lower candle power yield of the coal. Aside from coke there were no by-products. The gas yield per ton was a little under 6000 cub. ft., while under better conditions it should have been between 7000 and 8000 cu. ft. The high labor cost was due to entire lack of coal handling and other facilities. In this cost computation administration and fixed charges are not considered, and it gives no measure of cost at consumers' meters, where with maintenance of distribution system, leakage, etc., the cost must for the plant under consideration be thus increased by between 60 and 70 cents per 1000 cub. ft.

In the steam plant replaced by the gas engine station an 18,x 42″ slow speed simple non-condensing Wheelock engine did the portion of the work continued by the gas engines with a consumption of not over 3¼ tons of coal per 24 hours, giving comparison of cost of materials as follows:

Gas engines:
65900 cub. ft. at 60½ cents = $39.87.
Steam engine:
3¼ tons coal at $3.80 = $12.35.

Water and lubricant costs were at least four times as much with the gas engines, while attendance cost did not differ much.

The cost of gas can be reduced to under 40 cents per M. ft. for materials and labor with careful operation of a well equipped plant, and with large enough output to between 25 and 30 cents per M. ft. The losses between switch-board and prime movers are also exceptionally large for the station under consideration. On the whole, however, the conclusion reached was that gas engines cannot compete with steam with cost of gas any more than 30 cents per M. ft.

Some Experiences With Lightning Protective Apparatus.*

By Julian C. Smith.

This paper will deal with some experiences with lightning protective apparatus which the operating department of the Shawinigan Water & Power Company have had during the years 1903, 1904 and 1905.

The generating station at Shawinigan Falls has three generators each of 3,750-kw. capacity, 2,200-volt, 30-cycle, two-phase, and one generator of 6,600-kw. capacity, 2,200-volt, 30-cycle, two-phase. Each of these generators is direct-connected to a water-wheel operating under a head of 130 feet.

Referring now only to the long distance lines, it is sufficient to note that the energy is delivered through a double set of bus-bars to the low-tension side of the step-up transformers. These transformers are T-connected for transforming from two-phase to three-phase. The ratio of voltage transformation is 2,200:50,000. The neutral point of these transformer banks is grounded, giving about 29,000 volts between each wire and earth.

In 1903, only the No. 1 Montreal line was operating. This line connected the generating station at Shawinigan Falls, P.Q., with the Montreal terminal station, situated just outside the city of Montreal. The distance from the generating station to the terminal station is 85 miles. The transmission line consists of three 7-strand aluminum cables, each of 185,000 cir. mils cross-sectional area, spaced 60 in. apart and arranged in the form of an equilateral triangle with the apex upward. These cables are supported on 35-ft. poles, with cross-arms 6-ft. long fastened with through bolts. The top of every pole is bored to receive a pin. All pins are 18-in. long, and were boiled in stearine.

The voltage at Shawinigan is normally about 50,000; at the Montreal terminal station it is 44,000.

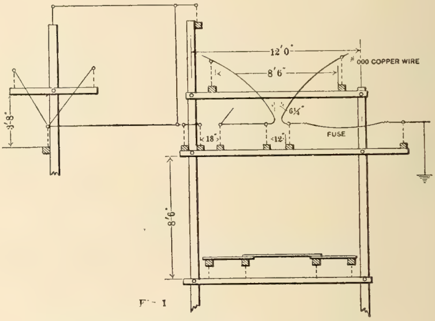
In the spring of 1904, a sub-station was built in Joliette, distant about 45 miles from the generating station, and from this sub-station a branch line was built to the city of Sorel. This line is about 20 miles long and is operated at 12,500 volts. The only special point of interest is a submarine cable about 5,000 feet long by means of which the line crosses the St. Lawrence River.

In the Montreal terminal station, the voltage is reduced to 2,400 and supplied to a set of 30-cycle bus-bars. From these bus-bars the frequency-changers are operated, each frequency-changer consisting of a 30-cycle synchronous motor connected to a 60-cycle generator. There are at present installed in this station five of these motor-generators each of 1000-kw. capacity, operating street railway circuits. It is interesting to note that the whole load of the long-distance line consists of synchronous apparatus, and that by properly regulating the fields of this apparatus the power-factor can be kept at unity.

In the fall of 1904 the No. 2 Montreal line was completed. The No. 2 line is parallel to the No. 1 line for nearly the entire distance, and in most cases is not more than 100 ft. distant. The second line is similar to the first except for the size of the conductor and for the fact that a ground-wire is strung along the line at the neutral point of the triangle. This ground-wire is connected to the earth at each pole by a wire running down the pole.

When the No. 1 line was put into service the lightning apparatus installed was as follows: At each end of the line was a bank of Westinghouse lightning-arresters of the low-equivalent type and a bank of static-interrupters. The number of gaps in these arresters was decided upon only after a series of tests had been made to determine the lowest practicable break-down voltage. These arresters were set to discharge at about 65,000 volts. In 1904 a bank of General Electric arresters was placed on the 50,000-volt line in the Joliette sub-station. This bank was also adjusted to discharge at about 65,000 volts.

In 1904 three banks of horn-arresters were put on the No. 1 Montreal line. These arresters consist of bent copper rods. The horns were spaced 6.25 in. apart at the gap, this distance corresponding to a break-down voltage of 90,000. See Fig. 1. In 1905, when the No. 2 line was equipped with lightning-arresters, three banks of low-equivalent arresters were put in, one at each end and one at Joliette. In addition to these arresters three banks of the 1905 type of horn-arresters were put in. Some changes were made in the setting of these arresters as will be noted farther on.



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Horn Lightning-Arrester, Joliette, Que.

The Montreal lines run in a general northeasterly-southwesterly direction, parallel to the St. Lawrence river and about 20 miles distant from it. The elevation of the power house is about 200 feet above sea-level, that of the sub-station being nearly the same. Some 10 miles farther north and parallel to the transmission lines, the Laurentian mountains bound the north side of the St. Lawrence valley. In general, the country over which the lines pass is a flat farmland, but near the power house the country is very rough.

The prevailing winds are westerly, and the general course of the electrical storms is parallel to the lines. The storm period extends from March to October. Nearly all the storms occur during the latter part of June, and in July, August, and early in September. The storms are most severe during July and August. In the territory covered by the lines of the Shawinigan company there occurs during each year about fifteen thunder storms. As these storms move along in an easterly direction and sometimes take days to cover the 100 miles; we have found that from June 25th to September 10th, a storm is reported nearly every day from some part of the line. In general, however, there are not more than four or five severe storms during each year, and these storms are most severe in well defined localities. The discussion of our experiences with lightning will be simplified if these experiences during 1903, 1904 and 1905 are considered separately, year by year.

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* Paper read before the American Institute of Electrical Engineers, New

As stated above, the only line in operation in 1903 was the No. 1 Montreal line. That line was protected by low-equivalent arresters at each end. During the summer of 1903, several disturbances occurred, which may be summarized as follows :

1. Poles splintered by heavy discharges.
2. In a few instances, insulators broken.
3. Flashes across the static-interrupter terminals.
4. Arcs on the transformer terminals.
5. Arcs inside the transformer cases at the top between adjacent leads.
6. Damage to apparatus caused by 3, 4, and 5.
7. Interruption to service, due usually to excessive voltage-drop, causing synchronous apparatus to fall out of step.

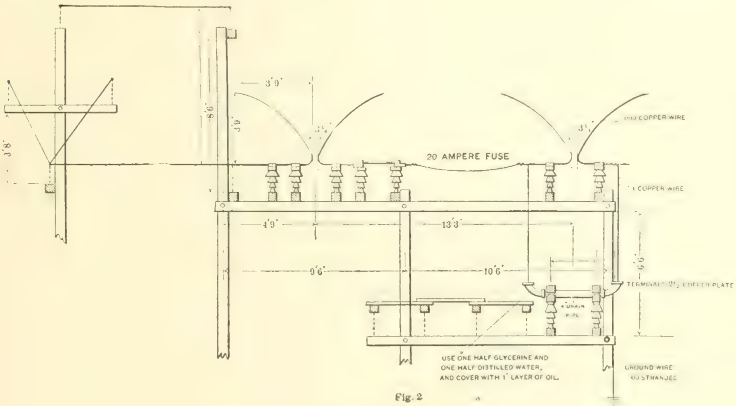

FIG. 2.—HORN LIGHTNING-ARRESTER AND RESISTANCE. TYPE 1905.

1. On several occasions poles were splintered. In most cases two or three poles were torn to pieces ; the adjacent poles on both sides were less damaged, the damage decreasing as the distance increased from the point of disturbance. One of the worst cases recorded by us shows that 5 poles were torn to pieces while 10 poles on each side were somewhat splintered. This disturbance extended over a distance represented by 25 poles, or about 2,500 feet. This case, however, is exceptional, usually not more than one pole is badly damaged, and a few of the nearby poles slightly splintered.

2. In only one or two instances were insulators broken ; in each instance it was the top insulator. In these cases, the breakage seemed due to the flashing over and consequent heating, as the insulator was not in any case punctured. In no case was an insulator so badly damaged as to need immediate replacing.

3. At the same time that the poles were splintered on the line, there would be evidences of excessive potential in the stations. The most frequent occurrence was an arcing over on the terminals of the static-interrupters. In some cases this flash would reach across to an adjacent static-interrupter and establish a short circuit between the lines. In most cases, however, it was simply a flashing from the ends of the terminal to the case, or between the incoming and outgoing wires of a single static-interrupter, thereby short circuiting the reactance coil.

4. The arcs on the transformer terminals were more rare, only occurring when the static-interrupters were put out of service by the flashing over mentioned above.

In view of the above disturbances and damage it was decided to put in a type of horn lightning-arrester affording a low resistance path to ground, to depend on a fuse for the interruption of the short circuit which would occur if the horns did not break the arc, and to set these horns so that only the heavier discharges would break them down. The horns were consequently adjusted to discharge at about 90,000 volts.

At the end of 1903, it was determined that the arresters installed were sufficient to meet the conditions caused by ordinary storms. They protected the line from abnormal rises of potential due to switching or short circuits ; but in those cases when the lightning-stroke damaged poles on the line the rise of potential was so high and took place so rapidly that the arresters could not carry enough current to keep the potential of the line within safe limits. The horns installed were especially designed to meet only the conditions which were not met by the standard arresters.

In 1904 there were more than the usual number of storms. On the following dates the horns discharged :

Date.	Shawinigan.	Joliette.	Montreal.
July 11	3 horns	1 horn	None
Aug. 5	2 "	3 horns	"
Sept. 20	2 "	2 "	"

One or two storms did not cause any disturbance.

The storm of July 11 was central near the power-station, and one pole about five miles distant was splintered. The Joliette horns discharged about an hour before the discharges took place at Shawinigan.

On August 5, the storm was central at Joliette. Both the horn arresters and the standard arresters discharged violently, the horns at Shawinigan discharging at the same time. There was evidently a rise of potential in the Joliette station, as one of the glass windows through which the wire enters the building was cracked, due to the flashing over which must have occurred. At the same time that this disturbance occurred in the station, some 25 poles about five miles away were splintered, a few of them very badly. No disturbance other than the discharge of the arresters occurred in the other stations. The service was not interrupted, a rather severe blow being felt, lasting only about a second.

On September 20, the storm was central about midway between Shawinigan and Joliette. Fifteen poles were struck. No excessive potentials were noticed in the stations, nor was the service interrupted.

During 1905, the number of storms was less than usual, but there were two very violent storms, both near Shawinigan. Poles on the No. 1 line were damaged. At various times during the summer the horns of both lines discharged, but it is noteworthy that the horns of two lines did not discharge at the same time; that is, the two lines only about 100 ft. apart would not be equally affected by lightning discharges.

The horn arresters on the No. 2 line were designed to take less current than those on the No. 1, as a resistance consisting of a mixture of glycerine and water was put in the ground connection; in parallel with this resistance was a horn-gap. During the first storms it was noticed that the resistance had "an equivalent spark-gap" greater than the horn, although the resistance was about 10,000 ohms and the gap about three inches. The resistance was greatly decreased early in the summer by pushing the terminals closer together and the gap was slightly increased. After this was done the lightning discharge went through the resistance.

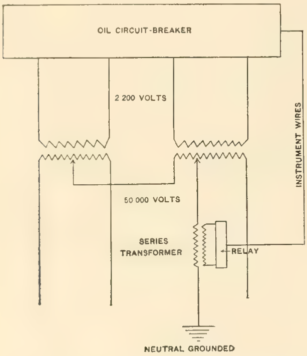

FIG. 3.—TRANSFORMER CONNECTIONS.

Note: Neutral point grounded through a series transformer and relay. Current in ground-wire, trips oil circuit-breakers.

Another factor came into play in 1905. The two long-distance lines are operated in parallel on the low-tension sides at both ends. As stated previously, the neutral point of the transformer banks is grounded at Shawinigan. A series transformer was placed in the ground-wire leading from each bank of transformers, and an overload relay connected to this series transformer so that if any considerable amount of current flowed into the neutral the relay would open up the low-tension side of all the transformers connected to that line. The operators in the Montreal terminal station were depended upon to separate the two lines in cases of trouble. By this means, a ground or heavy disturbance on one line would cut that line out of service. Our experience during the past year shows that this scheme works satisfactorily. To some extent, however, it masks the action of the lightning-arresters, as in case of heavy discharges over the horns the relay would cut off the line.

Summing up our experience with reference to the horns, I would say that we consider them a valuable addition to the standard equipment. Since the installation of the horn arresters, we have had no arcs in our station. No damage has been caused to our apparatus. No interruptions to our service have been caused directly by lightning. On the other hand, each time the horns discharged a more or less severe short circuit occurred, in no case, however, being severe enough to cause trouble or to cause our synchronous apparatus to fall out of step.

ELECTRICAL MATTERS IN BRITISH COLUMBIA.

Three 76 h. p. ten-ton electric locomotives have been purchased by the Crows Nest Pass Coal Company for hauling coal at the mines, also four electric pumps direct coupled to 3 h. p. motors, three Eddy motors for hoisting the coal out of the deeps, and eight direct current motors ranging from 5 to 30 h.p. for operating the steel tipple that has recently been installed for unloading coal from the carriers into the coal cars. Current for all these motors is supplied by four 135 h. p. direct current generators in the power station of the Crows Nest Pass Electric Light Company. This last named Company operate an electric lighting system consisting of two 2400 volt a.c. 31 ampere machines capable of 5000 lights. Power is transmitted from the station at the mines to Fernie, for lighting. Many of the new buildings going up at Fernie are being equipped for electric lighting, and Mr. R. B. C. Hammond, the city electrician, reports a constant rush of work on hand. The Trites-Wood Company's new store has been equipped with 12 Adams-Bagnall arc lamps and 63 incandescent sunburst lamps. The Crows Nest Trading Company have twenty-five 25 c.p. lamps in their new store. The wiring of the new offices of the Crows Nest Pass Coal Company is nearly finished and Mr. Hammond states it is the most up to date piece of electrical work on the Pass. A feature of electrical work in Fernie is that all the wiring is done on the panel system, each circuit not exceeding 12 lights. Another notable thing is that there is no exposed wiring or cleatwork in the town, all the wiring being concealed.

The annual meeting of the Peterboro Hydraulic Power Company was held recently, when Robert Stuart was elected president; John Stuart, vice-president; Robert Gordon, Chicago, secretary, and J. H. Larmonth, manager.

The annual meeting of the Peterboro Radial Railway Company was held last month, when the following officers and directors were elected: President, Robert Stuart, Chicago; vice-president, J. C. Shook; secretary and manager, J. H. Larmonth; H.P. Crowell, Chicago, and T. E. Bradburn, M.P.P. No decision was reached in respect to the extension of the road to Young's Point.

QUESTIONS AND ANSWERS

GENERAL RULES TO BE OBSERVED BY CORRESPONDENTS:

1. All enquiries will be answered in the order received, unless special circumstances warrant other action.
2. Questions to be answered in any specified issue should be in our hands by the close of the month preceding publication.
3. Questions should be confined to subjects of general interest. Those pertaining to the relative value of different makes of apparatus, or which for intelligent treatment should be placed in the hands of a consulting engineer, cannot be considered in this department.
4. To avoid trouble and unnecessary delay, correspondents should state their questions clearly, so that there can be no possible doubt as to the information required.
5. In all cases the names of our correspondents will be treated confidentially.

QUES. NO. 1.—Will you kindly advise me of the arrangement of the compensating device which is used in connection with hydraulic governors? Is such a scheme used in connection with the governors of steam engines, and if not, why not?

ANS.—The difficulty encountered in the control of water turbines is due to the fact that the gates are usually very heavy and are acted upon by the moving water, thus requiring a governor which is capable of exerting large power when necessary, and also to the momentum or inerta of the revolving parts. Owing to the slowness of the movement of the gates, the actual variation of the gate opening takes place some little time after the governor has noted the change in speed. It will be understood that this slowness of action produces trouble where water wheels are driving electric generators, and in other installations where a very steady speed is required. A generator may be running under full load and this load may be suddenly reduced. The turbine speeds up at once, and the tendency of the governor is naturally to bring the machinery back to its normal speed. However, in this case the governor will close the gates more than is really necessary to give the required speed under the new load, as inertia tends to keep the speed up for a few seconds, and hence the speed will fall below normal. At this point the governor opens the gate somewhat to bring the speed up again, but carries this action too far and the generator overspeeds for the second time. This see-saw action, which is called "hunting", would be kept up continuously if some compensating device were not incorporated in the governor's mechanism. The action of the compensator is to prevent the governor from fully responding to changes of speed. In the example just given the compensator would stop the closing of the gates a very little before the speed dropped to the required point, and hence when the inertia is lost the apparatus will come to the required speed, and thus the hunting will be eliminated. The compensator really makes the governor sluggish in its action and this sluggishness can be adjusted to any desired degree. Devices of this kind are seldom used in connection with steam engines, as the parts controlling the speed are usually very light, comparatively speaking, and are not affected or controlled in any way except by the governor balls themselves. The action of the steam engine governor is therefore very quick and exact and compensation is consequently unnecessary. A dash pot is usually used in connection with the steam engine governor, and this gives smoothness of movement, but is not in any sense of the word a compensating device.

QUES. NO. 2.—Can you give me any information regarding oil separators? Is there any process or separator that will extract the oil out of exhaust condensed water so it would be perfectly safe to use the water over again in the boilers?

ANS.—It is desirable to extract the oil from exhaust steam whether the steam is to be used for heating or whether it is to be condensed and returned to the boilers. The usual way of eliminating the oil is by placing an oil separator in the exhaust pipe of the engine, and if this separator be of a good make and in good condition it should successfully remove the oil. The cheaper form of these separators is a construction very similar to that found in the ordinary steam separator, the steam coming in contact with baffle plates and the oil being deposited in the same way in which moisture is eliminated from live steam. In another type of separator baffle plates of larger size are used, these plates being built hollow, and cooled by means of circulating water. Other types of separators have in them a series of lattice work plates which are removable, and upon which the oil is deposited. If you wish to use the condensed steam for boiler feed you will probably find that a good oil separator in the exhaust pipe will prevent trouble.

QUES. NO. 3.—We have installed here two fifty kilowatt belted direct current generators running from a line shaft driven by a slow speed corliss valve engine. We wish to make a test on these generators before accepting same from the manufacturers, but as yet have not got enough lamps and motors connected to give full load to even one of the machines. Is there any way in which we can run a temperature test on this apparatus with our present facilities?

ANS. — Probably the simplest way in which to get a load for testing your generators would be to use a water rheostat, which can be made up with a barrel, two pieces of plank, and two pieces of gas pipe. This rheostat could be connected through a switch to either the bus-bars on the switchboard, or to some convenient feeder circuit of sufficient size. Full load could then be placed upon the machines and a temperature test run without interfering to any great extent with the lights and motors which you are at present operating. The water rheostat can be adjusted to take that part of the load which in combination with the energy required by the lights and motors will go to make up the full load capacity of the generators. We would caution you to add salt to the water rheostat with considerable care, as when the water commences to get hot the resistance of the rheostat decreases rapidly, and the apparatus will in consequence take more energy than desired. Add but little salt to the water at first and let the rheostat come up to the hot point slowly. Then if more salt be required it can then be added, and the proper resistance obtained. It would be possible, of course, to load one generator into the other. To do this the equalizing connection would have to be removed and the series field of one of the machines reversed. This machine will then be in a position to act as a compound wound motor. Your engine should be started and the machines brought up to speed. The voltage of each should be carefully adjusted and then the machines should be paralleled by closing the main switches in the regular way. The resistance in the field rheostat belonging to the machine to be run as a motor should be increased. This will weaken the field of the machine and energy will flow from one generator to the other. By manipulation of the rheostats full load voltage may be obtained with full load current flowing between the machines. In this test the engine will be called upon to supply but very little power; in fact, only that required to overcome the friction of the shafting and belts and to make up the losses in the two machines. If you decide to run the temperature test in this way it is necessary that a circuit breaker be connected in the line between the two generators. If you are experienced in handling machines connected by this method you can no doubt run a satisfactory test, but for simplicity we would suggest that you make use of the water rheostat.

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Correspondence is invited upon all topics coming legitimately within the scope o this journal.

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

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English Street Lighting.

We have before us a report from one of the English cities concerning the relative costs and results of gas and electric street lighting, and which, from our point of view, is characteristically vague and incomplete. The figures concern a certain road, seven to eight hundred yards long, and forty-five feet wide, upon which the tests were made, and the following statements are presented therewith: The original illumination was obtained by means of twenty-five Welsbach burners, burning four cubic feet of gas per hour, and giving one hundred and fifty candle power each with new mantles. These lamps were furnished at $30 per year of four thousand hours, making a total of $750 for three thousand seven hundred and fifty candle power. These gas lamps were replaced with twenty-two electric arcs, costing $40 per year of the same number of hours, making the total cost $880 per year. The electric arcs were figured at three hundred candle power each (which leads us to suppose that they were smaller than the standard lamp used on our streets), making a total of sixty-six hundred units of light. The situation is summed up in the statement that seventy-six per cent. more light was furnished by the electric arcs, at an increased cost of a little over seventeen per cent. As mentioned before, the figures which have come to us are woefully lacking in details, but they are placed in these columns in the form in which we interpret them for what they are worth.

Angular Velocity.

A device was placed on the market not long ago which promises to be of material assistance to engine builders in the determination of angular velocity. The old tuning fork method, while accurate enough in its way, was never entirely satisfactory, and at the best an incomplete record was the most that could be expected. In the new scheme the essential part consists of a small electric motor, with permanent field magnets, running at a suitable speed and having energy supplied from a circuit of as near a constant potential as can be obtained. The motor is mounted on a sliding base, this base moving in a direction parallel to the shaft of the engine under test. The motor shaft is in a vertical position, and mounted on the upper end of this shaft is a small pulley to which is attached a wiper. A tracing needle is attached to the motor and this serves to make a line on the surface of the engine fly wheel. This surface is prepared in the usual manner by rubbing with chalk and on this surface two marks are made, one a continuous spiral line made by the tracing needle and the other a short crossing line made by the wiper. When the engine is running the motor is brought into the proper position with the tracing needle just beside the fly wheel. The motor is then started and by means of the sliding base is pushed slowly across the face of the wheel, the tracing needle making the continuous spiral line and the little wiper making the cross marks. The speed of the motor should be such as to make a mark every six or eight inches. When the engine is stationary a zero point is obtained by setting the crank on the dead centre and drawing the tracing needle across the face of the fly wheel. This device has been very successfully used in taking readings of the angular velocity of gas engines, and it is quite likely that its use will give to the builders of both gas and steam machines information which has for a long time been greatly desired.

Compensated Alternators.

At a recent meeting of one of the English Electrical Societies a paper was read pertaining to the above subject, and many interesting points brought out. It was stated that there are to-day nine different methods of compensation, and that all of these apply to the excitation of the alternator, or in other words, a change in the field current of the machine is effected, which tends to maintain the terminal voltage constant. When operating on a unity power factor, such schemes can be made very satisfactory, but where the power factor is less than unity (either leading or lagging as the case may be) the system refuses to produce the required results. If a device could be developed which would maintain constant voltage on the generator terminals, or which would allow adjustment for a reasonable degree of increasing pressure, irrespective of power factor, such a thing would be in great demand provided that it could be relied upon. All such schemes have been a part of the alternator itself, and in this particular we think that an error has been made. We have in mind a regulator placed on the market some time ago, which can be adjusted to keep a constant voltage at a given part of the system, irrespective of load and power factor. This device is essentially a switchboard instrument, and the success which has come to it is no doubt due to the fact that the inventor tried, as a first step, to get away from the idea of getting out an appliance which was essentially a part of the machine which it controlled. It is in incandescent lighting that close regulation is required. A three or four per cent. variation produces complaints from the lamp users, while a much greater variation would not be noticed in a motor. Hence, to our mind, a transmission system should be laid out with the lighting and the power transmission lines and distributions entirely separate, and a regulator should be installed in the power house, which would maintain a constant voltage at the receiving and distributing ends of the lighting lines, without regard to what is going on in the power department. In England it has been suggested that a generator be built with intermediate poles, working somewhat on the same principle as the intermediate-pole multi-speed motor. Of course, such a scheme would have the advantage of being very quick in its action, and this feature is not found in all machines as they are compensated to-day. The idea is a step in advance, but still the power factor end of the problem would remain in the same unsatisfactory condition. The use of uncompensated machines, especially in moderate and large sizes, is now almost universal on the American continent, and the station attendant is relied upon to keep the voltage at the proper point. With a voltmeter, an ammeter, a power factor meter, and a proper table, he can do this with some difficulty. Perhaps with the uncompensated machine the voltmeter compensater comes in as the most handy device, giving as it does the voltage at the end of the line irrespective of power factor. But still we think that the most satisfactory of all schemes is the use of a properly built and properly adjusted automatic regulator which is not a part of the generator, and which will successfully eliminate the personal equation.

The Necaxa Plant.

The development at Necaxa, Mexico, is of particular interest to Canadian engineers, inasmuch as many novel features have been introduced into this equipment, and the whole has had the backing of Canadian capital. The gentlemen interested in the Electrical Development Company of Ontario and the Toronto-Niagara Power Company have been behind this power plant for the City of Mexico, and therefore many of the new ideas which are to be seen here in our own country have been used in the Necaxa plant, and vice versa. In the transmission line proper the general scheme is identically the same, with the one exception that in Mexico much longer spans are used, with the same spacing of wires, and the same weight and height of poles. This is readily explained when one considers that the worst enemy of the long span is sleet, and that in the Canadian line allowance has been made for this, while in Mexico this bad feature does not enter into consideration. Hence it will be understood that in the Toronto-Niagara line the standard span is four hundred feet, while in Mexico the distance is considerably more than this, some special spans running as high as twelve hundred feet. The general details of the Canadian line have already been described in this paper, and therefore being familiar to our readers need no further comment. In Mexico, however, the hydraulic development differs very materially, for the head at Niagara is small compared to that obtained at Necaxa. Two rivers furnish the supply of water, and owing to the curious geological formation, have a drop of over three thousand feet in a distance of three miles. It was not a commercial proposition to develop this full head, but a scheme was hit upon which has certainly been found satisfactory so far. The waters of the two rivers have been joined and impounded in a large artificial reservoir at Necaxa. From this point a combination of pipe lines and tunnels has been built to the first power house, a mile away, giving a working head of about fourteen hundred feet. It is the plan of the company to build a second power house further down the river at which the same water will be used over again, but this time with a head of something over one thousand feet. The combined capacity of these two equipments will, so it is stated, be in the neighborhood of eighty thousand horse power, and a total distance of transmission has been figured upon of one hundred and seventy miles. At Niagara the wheels are, of course, of the standard reaction type, built vertical, while at Necaxa an impulse turbine is being used, also of the vertical design. The runners of these turbines are about nine feet in diameter, and operate at a speed of three hundred revolutions per minute. Two regulating nozzles, placed diametrically opposite, deliver water to the buckets, and give each wheel a capacity of approximately eight thousand horse power under the head mentioned. The current from the generators, at four thousand volts, is carried to step-up transformers of the oil-insulated, water-cooled type, and transformed to a potential of sixty thousand. The main control switchboard is of the bench type, similar to that to be used at Niagara, and is noticeably small, even for a plant of moderate size. The old electric lighting station at the City of Mexico has been remodeled as a substation, and to the old equipment there have been added four turbo-generators, each of five hundred kilowatts capacity. Taken as a whole, this plant, and the one building at Niagara, will form a pair of systems which for soundness of engineering will be hard to equal.

AN ELECTRIC ACCELEROMETER.*

By R. B. Owens, M. Can Soc.C.E.

The advent of the electric motor as a competitor of the steam engine, especially in the traction field, has given rise to certain acceleration problems unfamiliar to engineers of a generation ago. At a time when the train mile was a satisfactory unit in which to reckon haulage costs, there was little occasion to bother with acceleration. Now, however, when neither the train mile, car mile, nor ton mile suffice, even when coupled with a speed factor as a basis of estimation and analysis, now when to maintain certain schedules more energy is expended in accelerating than in overcoming frictional and grade resistances, a simple, accurate and reliable means of measuring acceleration is urgently demanded—a means at least comparable in simplicity and accuracy to those employed in the measuring of the quantities of which it is the second and first differential with respect to time. The measurement of length is familiar to all. Of practical methods of measuring velocity or speed, at least of machines, one of the most satisfactory, if not the most satisfactory, involves the use of a suitable constantly excited or permanent magnet dynamo mechanically driven by the piece whose velocity is to be measured, and electrically connected through an ammeter to a circuit of constant co-efficients as shown in Fig. 1.

S is the shaft whose velocity is to be measured. C is a mechanical coupler. A is the armature of a small permanent magnet or constantly excited continuous current dynamo wound so as to have a negligible reaction within the limits of its use. R is a variable non-inductive resistance, and I is a zero centre d. c. ammeter. The reading of I will be proportional to the speed of S and by adjusting R can be calibrated in the revolution per minute, feet per second, or miles per hour as desired. As the current through I is proportional to speed, it is only necessary to determine the rate at which the current varies in order to have a measure of acceleration. This is simply and easily done by inserting in the circuit with I a transformer T with its secondary connected, for purposes of adjustment, through a non-inductive resistance R_1, to a zero centre d. c. voltmeter V (see Fig. 2). The reading of the voltmeter V will then be proportional to the acceleration, positive or negative, of the shaft S.

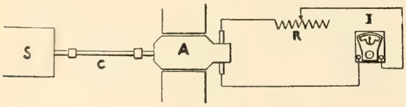

Fig. 1.

Substituting recording instruments for the indicating ones shown, we have a recording speed indicator and a recording accelerometer. The transformer must have a straight line saturation curve and a large transformation ratio, as the secondary induced voltage is necessarily small and the voltmeter V must also be sensitive. The calibration of the ammeter as a speed indicator is effected by driving the armature A at different constant speeds as shown by ammeter reading, and taking the revolutions in a given time by means of a revolution counter and stop watch. The calibration of the voltmeter as an accelerometer is best done by driving the armature A by a separately and constantly excited motor having applied to its armature, preferably of small momentum, a voltage varying approximately as a linear function of time. With proper manipulation of apparatus the ammeter readings plotted against time will be a straight line whose slope will be constant and equal to the acceleration and to the constant reading of the voltmeter to within a constant.

In some tests made in the writer's laboratory not long ago, A (see again Fig. 2) was the armature of a small low voltage separately excited d.c. generator; S the shaft of a 3 h.p., separately excited d. c. motor to whose armature by a potentiometer arrangement a steadily increasing or decreasing voltage could be applied; I and V Weston ammeter and multivoltmeter and T a small lighting transformer with a transformation ratio of 20, and excellent results were obtained, speed and acceleration being read to exactly the same degree of accuracy that Weston d. c. ammeters and voltmeters are capable of. With recording instruments substituted, this would seem to meet every requirement of a practical apparatus for the measurement and recording of velocity and acceleration in railway work, both steam and electric, and is applicable, of course, in many other connections.

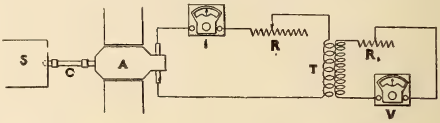

Fig. 2.

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* [illegible] Electrical Section, Canadian Society of Civil Engineers, Montreal, November 2nd, 1905.

ELECTRIC LIGHTING AND TELEPHONY AT CRANBROOK.

The Cranbrook Electric Light Company, Cranbrook, B.C., are also the owners and operators of the East Kootenay telephone lines, being one of the few independent telephone companies in British Columbia. They have at present nearly 150 subscribers on their system and the switchboard is about taxed to its utmost. They have in addition to the local lines about 100 miles of trunk lines for long distance, these extending westward as far as Moyie, north as far as Kimberly and east to Fort Steele and Wardner, covering in all a radius of over 30 miles from Cranbrook. The central office is equipped with a J. D. Kellogg magneto switchboard of 150 drops and all the instruments are Kellogg's long distance phones, which are proving highly satisfactory. The bridging system is in use on all the trunk lines. The system has been in operation only about four years, but in that time it has grown so extensively as to necessitate the immediate acquiring of larger quarters. The company intend erecting their own building. Another switchboard of at least 150 drops will then be installed in addition to the present board in use, and this is expected to meet the demands for some time to come.

The system is in charge of Mr. H. G. Curtis, formerly of Brantford, Ont., Mr. Maurice Quain being chief electrician in charge of the mechanical features.

The electric lighting system, which has been in operation four years, has also grown rapidly. At first a 35 k.w., 110 volt generator was sufficient, but this soon had to be added to by a 72 k.w., 110 volt C.G.E. generator. They are now operating about 3,500 lights. An increase in this department is also an immediate necessity.

NEW SUPERINTENDENT APPOINTED.

The announcement was made during the past month of the appointment of Mr. James Milne, M.E. & E.E., Toronto, to the position of General Superintendent of the British Columbia Electric Railway Company, rendered vacant by the resignation of Mr. F. Hoffmeister owing to ill health. The appointment suggests the extending of congratulations on both sides, for while Mr. Milne was honored by being selected for the position, the British Columbia Electric Railway Company are fortunate in securing the services of such a capable and talented engineer. The operations of the company include electric railways and light and power services in Vancouver, New Westminster and Victoria, as well as several miles of interurban road, the whole representing a system of great magnitude demanding skillful superintendence, and Mr. Milne will, we believe, prove to be the right man in the right place.

James Milne is a Scotchman, having been born at Woodside, Aberdeen, on January 29th, 1865. He received a first-class technical education at Gordon's College, Aberdeen, and served an apprenticeship of five years in mechanical engineering, 1881-1885. Nineteen years ago he came to Canada and was for several years engineer with the Edison General Electric Company, later becoming chief engineer for the Keegans-Milne Company, electrical engineers and contractors, Montreal. Upon resigning this position he was appointed general superintendent of the Incandescent Electric Light Company, Toronto, which position he occupied for six years, during two years of which he was lecturer at the Toronto Technical School on the subjects of Steam and Steam Engine, Applied Mechanics and Electricity. Although the Technical School was then only in its infancy, these classes were a marked success.

Mr. James Milne, M.E. & E.E.

General Superintendent British Columbia Electric Railway Company.

For the past eight years Mr. Milne has done a consulting engineering business, while at the same time being manager and chief engineer of the General Engineering Company and later of the Underfeed Stoker Company, of Toronto. He has frequently been retained in an advisory capacity by the city of Toronto and other corporations and is recognized as one of the first engineers of the day, possessing both the technical knowledge and practical experience.

While the financial remuneration in his new field of labor may represent a loss for some time, yet, having unbounded faith in the future of Western Canada, Mr. Milne feels that the prospects warrant the change. He will assume his new duties early in February, and while his many Eastern friends regret his removal from among them, they predict for him the full measure of success which his recognized ability and energy are almost certain to bring.

A NEW FRENCH ARC LAMP.

A new and ingenious type of arc lamp has been devised by M. Klostermann which possesses some interesting features. The idea of the inventor was to devise a lamp, simple, and yet with sufficient stability to be used four in series on 120-volt circuit, thus doing away with regulating resistances. The lamp consists of two carbon-holders, fed together by means of a simple arrangement of suspending wires, and regulated by one or two electromagnets, as the case may be, for the lamp is made with either a series or a series-and-shunt control. The series-and-shunt lamp regulates by means of two electromagnets, one placed in series with the line, and the other in shunt across the arc. Each of these magnets attracts an armature, which is thus caused to oscillate around a horizontal axis. The two armatures are, however, attached together so that the two magnets act in opposition. The carbon-holders are suspended by means of two loops of flexible wire, which also carry a loose pulley turning on a spindle, somewhat below the axle of the rocker. The flexible wire passes over this loose pulley, forming the two loops on opposite sides, from which the upper and lower carbon-holders are suspended. The upper carbon-holder is weighted, so that it naturally tends to descend, and thus raise the lower holder, causing the carbons to approach. This action can take place freely, except when the loose pulley mentioned above is blocked by a spring brake attached to the rocker arm. The action of the lamp is as follows: Assuming the carbons to be separated, the difference of potential across the shunt magnet causes the latter to draw to it its armature. This throws the rocker arm to the right, loosening the brake of the loose pulley, and thus allowing the two carbons to approach. As soon as they come in contact, current passes through the series coil, which then overcomes the shunt coil, and turns the rocker arm in the opposite direction. This action blocks the loose pulley on the rocker arm, and at the same time separates the two carbons, striking the arc. As the carbons burn away, the shunt magnet gradually overcomes the series magnet, and thus causes the rocker arm to tilt to the right and bring the carbons closer and closer together, until finally a point is reached where the spring brake lets go of the loose pulley, the carbons approach and come in contact, and the cycle is repeated.—Abstracted from L'Electricien (Paris).

Some motor generator sets of an interesting character have recently been supplied to the Acton Urban District Council by the Lancashire Dynamo & Motor Company, of Manchester, Eng. These sets are for running off a 10,000-volt, 60-period, two-phase circuit, and are to take current from the supply mains of the Metropolitan Electric Company. They will generate direct current at 460 to 500 volts, and can deliver 550 amperes at this voltage. This is 250 kw., and full load speed is [illegible] r.p.m.

A NOVEL WATER HOIST.

The question of unwatering a mine always is a serious problem to the mine management, especially so when the water is highly impregnated with acids. When the amount becomes excessive the means to be employed for disposing of it taxes the ingenuity of all concerned to the uttermost.

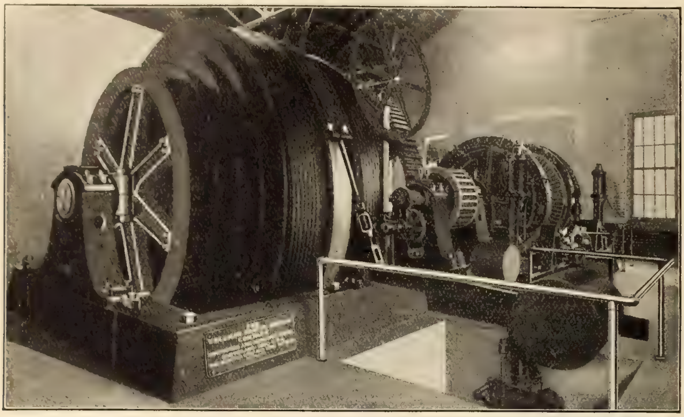


Fig. 1.—Front View of Hoisting Machinery for Water Hoist.

In the anthracite regions there are mines in which for every ton of coal raised, as high as 14 tons of water must be pumped and the latter must be done at a minimum of expense. Nowhere, probably, have a greater variety of pumps and lifting devices been tried—and the most satisfactory type, up-to-date, for handling large quantities of water at comparatively low heads, have proved to be large bailers operated by steam engines. These, however, lack the mechanical regularity inherent in a pump, as they are necessarily operated by men, and it remained for The Delaware, Lackawanna & Western Railroad Company and its electrical engineer, Mr. H. M. Warren, to finally develop a water-hoisting equipment which would preserve all the valuable points of the steam hoist and at the same time operate automatically. The carrying out of the mechanical details of the hoist and its automatic devices were confided to The Wellman-Seaver-Morgan Company, of Cleveland, Ohio, and the successful operation of the plant reflects great credit on the latter, as they guaranteed the machinery to accomplish the desired results. Most of the electrical controlling devices were furnished by The Electric Controller & Supply Company, of Cleveland, Ohio.

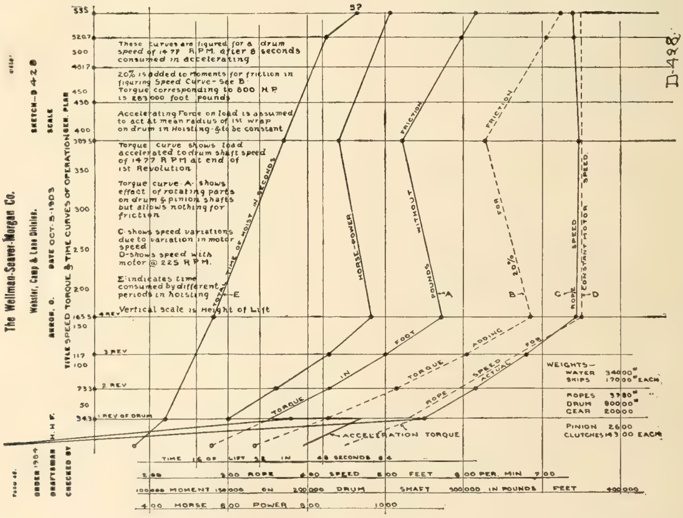
In the original specifications the D. L. & W. R. R. Company, called for the hoist to be operated by an alternating current motor of 800 h.p., and the question of starting, stopping and reversing so large a motor had, at the outset, to be met. The duty to be performed by the hoist called for the raising of 4,000 gals. of water per minute to a height of 550 feet.

4,000 gals. × 8.27 = 33,180 lbs.
550′ 2″ rope × 6.3 = 3,465
36,645 lbs. to be raised @ 550 ft. per min.

$$\frac{36{,}645 \times 550}{33{,}000} = 610 \text{ net horse power.}$$

Weight of bucket = ½ weight of water, so that weight on rope = 53,235 lbs. or nearly 27 tons, requiring 2 in. steel rope.

The various preliminary speed and movement diagrams are laid out per accompanying diagram.



It was decided in carrying out the design that it would be impracticable to design the hoist other than have a motor running continously in one direction, as it is a well-known fact that the amount of current required to accelerate a large motor of this type is enormous, and greatly interferes with the proper running of the power plant.

The D. L. & W. R. R. Company desired to use an a.c. motor directly at the hoist, and as the motor was to run continuously in one direction, this necessitated the use of friction clutches for accelerating and reversing the load.

As the Wellman-Seaver-Morgan Company had several smaller plants already in operation using a.c. motors on hoists which are operated similarly to the present hoist, and as they are running successfully, and the repairs and renewals for clutches had not exceeded that required for the other hoisting engines, it was decided to use this method.

Figs. 1 and 2 show a front and side view of the hoist· As will be noticed the general arrangement consists of a motor driving a pair of bevel wheels through a single bevel pinion. The bevel wheels run loose on a shaft and are fitted with the well-known Webster, Camp & Lane friction clutches. The operating mechanism for the clutches are so designed that only one clutch can be thrown in at a time, but both clutches can be out at the same time. Throwing in one clutch runs the drum in one direction; throwing in the other clutch reverses the motion of the drum.

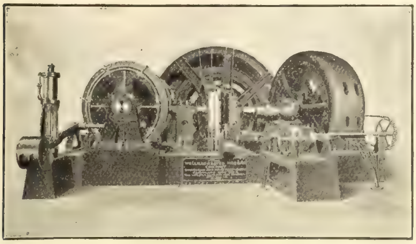


FIG. 2.—END VIEW OF HOISTING MACHINERY FOR WATER HOIST.

To the shaft on which the bevel wheels run there is keyed a pinion meshing with main gear on the drum shaft. The drums are of the cylindro-conical type 10 ft. at the small diameter and 16 ft. at the large diameter. At a hoisting speed of 550 ft. per minute the drum makes about 15 r.p.m. There is one main brake located between the drums. All of the clutches and brakes are operated by auxiliary air cylinders fitted with oil cushion cylinders, the compressed air being furnished by a motor driven air compressor and the necessary tanks located near to the hoist. The hoist is controlled by a mechanical device shown in Fig. 2. This device consists mainly of a drum rotated by means of a friction drive from the motor through a sprocket chain. The drum shaft transmits its motion to a secondary shaft fitted with variable speed which in turn operates a secondary stop. The main hoisting drum shaft operates a travelling nut, which is so located with respect to the controller drum that at either end of its travel it releases a stop and allows the controller drum to make a quarter turn ; this movement, through suitable electrical connections, operates the solenoids on the clutch valve, releasing the clutch and the solenoid on the brake valve setting the brake, the further movement of the controlling drum being arrested by the secondary stop. This stop is released by the variable speed shaft and its connections, which has been given a predetermined time movement corresponding to the interval for emptying the bucket. The further movement of the controlling drum releases the brake and throws in the reversing clutch thus starting the hoist in the opposite direction, and also starting the travelling nut on the controlling mechanism in the opposite direction. At the end of the hoist the cycle of controlling movement is repeated and so on, making the hoisting operation continuous and automatic. Every attention has been given to the safe operation of the hoist. The main brake is of the gravity type and to be released the current must be on the solenoid operating the valve so that air can be admitted to the underside of the brake piston.

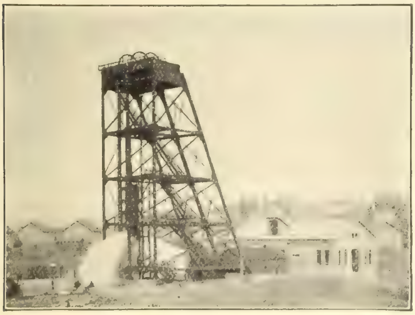


FIG. 3. GENERAL VIEW OF WATER HOIST, SHOWING MACHINERY HOUSE, HEAD FRAME AND BUCKET (DISCHARGING).

If for any reason, either the supply of current or of air pressure is interrupted, the valve drops, and the weights on brake lever set the brake. The clutches are designed so that they are thrown out by weights. As is the case with the brake, either clutch can only be thrown in when the current is on the solenoid, and the air pressure admitted under the piston, and if either current or pressure fail, the clutch is off. The motor shaft is fitted with an emergency brake operated by a weight controlled by a solenoid—any interruption in the flow of current to the motor sets the brakes and stops the motor. Any interruption of the flow of the current stops the machine throws out the clutches and puts on the brake.

A safety cut-out is provided for in the head frame so that in case a bucket is carried beyond the proper height, the current is cut off. Fig. 3 shows the head frame. The head frame is 93 ft. from the base to the center of the sheave at the top. It is built of structural steel, roughly in the shape of an "A". From the head frame are suspended two buckets 6' in diameter and 19 ft. 6 in. deep. The capacity of each bucket is 17 tons of water. In the bottom of the bucket are located two lift gates with an area practically equal to the cross section of the bucket.

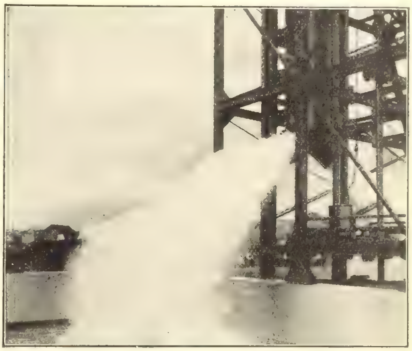


FIG. 4.—NEAR VIEW OF WATER HOIST BUCKET (DISCHARGING.)

These gates are lifted automatically when the bucket reaches the top, and the water is discharged through the bottom into a spout fitted below the bucket, and which deflects it to either side of the shaft. Each bucket makes a complete round-trip in one minute and fifty seconds, the total lift being 555 feet.

Fig. 4 shows a nearer view of the bucket when discharging.

In a test of a high duty pumping engine, which has recently been installed at Moose Jaw, the machinery has proved most satisfactory. An efficiency of almost 10 per cent. higher than the specifications demanded was demonstrated. The plant was installed by the Builders' Iron Foundry. of Providence, and the test was made by Prof. Kenison.

A pumping engine safety stop valve for cutting off the steam supply to the engine in the event of a break in the water mains is employed at the Hinksford station of the South Staffordshire waterworks, England. The valve is double-seated, after the fashion of a usual type of balanced valve, and the stem extended above the body terminates in a 2 inch gun metal plunger in a cylinder which is in communication with the water main. The stem is also attached to one end of a weighted lever which insures the closure of the valve when there is no pressure in the hydraulic cylinder ; otherwise the water pressure acting on the plunger is sufficient to hold the weighted lever and the valve stem in the position corresponding to the full opening of the valve.

TORONTO BRANCH A. I. E. E.

The twenty-sixth regular meeting of the Toronto Branch of the A.I.E.E. was held in the spacious rooms of the Engineers' Club, 94 King street west, on Friday evening, December 8th. At this meeting Mr. R. T. MacKeen was unanimously elected Chairman, to fill the vacancy caused by the resignation of Mr. H. A. Moore, who recently removed to Montreal to fill a more lucrative position with his Company, the Allis-Chalmers-Bullock, Limited.

The paper of the evening, "The Multiple Operation of Transformers", was presented by the author, Mr. R. T. MacKeen, and was followed by a most profitable discussion.

The importance of a thorough knowledge ot the principles involved in the multiple operation of transformers was well brought out by Mr. Black in his remarks opening the discussion.

While the treatment of the subject by the author might not be of much practical use when considering transformers situated unsymmetrically with respect to each other and the load, yet when dealing with the problem of dividing loads among larger transformer units in substations and where transformers are immediately adjacent to each other, the treatment described became most valuable, and enables one to prejudge the results quite accurately.

As evidenced by the remarks of those taking part in the discussion, the chief value of the paper was in the simple explanation of the way in which the various characteristics of the transformers governed the load division. The principle that the load division is inversely proportional to the impedance of a transformer and not proportional to the regulation was clearly demonstrated.

The importance of measuring individually the load division among transformers arranged unsymmetrically with respect to each other and the load, due to changing load centre, etc., was specially emphasized. Such measurements can be easily made with a "cable transformer" and show conclusively the exact conditions under which the transformers are operating.

This paper was published in full in our issue of November, and should prove of special benefit to central station men controlling the arrangement of distributing systems.

TURBINES OF THE ONTARIO POWER COMPANY.

A horizontal turbine of the largest capacity ever built has been assembled in the power house of the Ontario Power Company, Niagara Falls. The turbine stands 13 ft. in height above the floor, and the bed plates measure 21 by 29 ft. It was designed and built by J. M. Voith, Heidenheim a. d. Brenz, Wurttemberg, Germany, and is the first of twenty to be installed for the development of 200,000 electrical h. p., each turbine driving a 10,000 h.p. generator. They are rated as follows: 11,340 h.p., 20 cu. meters (700 cu. ft.) per second, 187½ revolutions, when operated under a head of 53.4 meters (175 ft.).

The turbines are of the inward-flow, double Francis type, having two runners of 78 in. in diameter, each capable of developing 5,700 h.p. The water is controlled at the turbine by swivel gates, which also act as guides. Lombard governors will be used. Relief valves are provided at the end of each penstock, discharging directly into the tail race.

These enormous turbines are supplied by penstocks 9 ft. in diameter, which enter the power house below the floor level. Where each penstock enters the building, a heavy thrust flange is imbedded in the enormous mass of concrete which forms the foundation of the entire plant. The thrust of the water column equals 650,000 pounds for each turbine. The turbines are set above, to one side of, and with shafts parallel to the penstocks, so that the supply pipes turn at an angle of 90° on the horizontal and 45° upward. The supply pipe ends in a spiral housing of heavily reinforced plates.

DEVELOPMENT OF SMALL WATER POWERS.

In a recent issue of the American Electrician there appeared an interesting article by Bell on the development and utilization of water powers having a capacity ot less than 500 h.p. The author assumes a stream having a reliable flow of 100 cubic feet per second during the dry months and a working head of 25 ft., the maximum flow being 400 cubic feet. The assumed average minimum flow would yield just about 225 h.p. if utilized with a first-class turbine, and the electrical product of this power—a little over 150 kw.—could be sold 24 hours per day, save for a few days at a time in very dry years. For nine months of the year twice this output could be delivered. Since an electric light plant would be the best customer for this power, the author considers how far storage can be brought into play to build up an output big enough to be of some use. With a normal minimum flow of 6,000 cubic feet per minute the working power for a 12-hour run can be developed by storing a little over 4,000,000 cubic feet of water. This would mean drawing down a 100-acre pond 1 ft. at night and letting it fill up when the load is substantially off during the day. In a very dry year there may be a further deficit of flow amounting to a little over 2,000,000 cubic feet in every 24 hours, so that the storage pond can be planned for if feasible. The development of the power does not require a large outlay. A well-ballasted timber crib is recommended for the dam. A small penstock is recommended. The number of hydraulic units should be so chosen that the temporary crippling of one will not cause serious inconvenience. The total capacity should be put, say, in four 150-kw. machines. Any more than this would probably lead to increased expense, and any less might cause too severe an overload in case one machine shut down. Regarding the electrical system to be employed, if the power was to be developed for lighting, the system is not of much consequence, direct current answering this purpose; if the power is to be transmitted a moderate distance, and loose pulleys are used on all but the smallest motors, a straight single-phase system answers, but where the power is transmitted a long distance and the actual distribution is carried from a sub-station, a 10,000-volt transmission line is recommended. A possible supplementary steam plant is suggested in connection with the sub-station.

The Stephenson Belting Company, Limited, has been organized at Toronto, with a capital of $40,000, the directors including J. E. Stephenson, William Stephenson, B. G. Stephenson and William Gillespie.

AN IDEA IN REDUCTION GEARS.

By W. B. McLean, B.Sc.

In all our modern motive power machinery there would seem to be a distinct and growing tendency towards high speed. Small motors for driving separate machines or groups of machines are coming more and more into use and the coming generator of power for the central station would seem to be the steam turbine. This all tends to the use of speed reduction gears of one form or other, and the need for a gear which is efficient and cheap and will reduce a very high speed down to a low one is becoming more and more acutely felt. Belts, chains, and spur gearing all have their limitations in this respect, as also has worm gearing. They would be of little use, for instance, in connection with a powerful turbine.

The device which this article proposes to describe does not pretend to be an adequate solution of all the difficulties in connection with this problem, but does involve one new idea, namely, the use of centrifugal force which has great possibilities and may perhaps lead to the right solution.

Consider the case of a turned roller rolling around the internal surface of a bored ring. The centrifugal force will throw it against the ring with a force proportional to the square of the number of revolutions it makes around the ring and its weight. If instead of one ring we use two and the roller be parallel the case is the same. But suppose one ring be made a little smaller than the other and the roller be turned to two sizes, the difference in diameter of the two steps of the roller being the same as that between the two rings, if the roller be now rolled around the inside of the two rings at such a speed that the centrifugai force will prevent slipping, then the rings must move in relation to each other, if one of them be held fixed in a frame the other must revolve slowly. It is evident that the motion of the roller may be obtained by having pivots at its ends arranged to run in bearings in a crank arm, the axle of which is at the centre of the two rings. The pivot bearings must have sufficient play to allow the centrifugal force of the roller to be taken by the rings, not by the pivot bearings.

— FIG. 1 — — FIG. 2 —

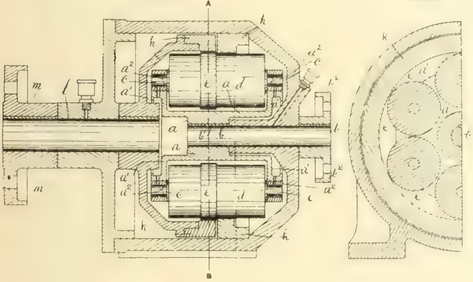


Fig. 2.

This idea is embodied in the machine shown in figures 1 and 2. Figure 1 is a sectional elevation: the high speed shaft is shown at "b" and is attached to the motor or turbine of which the speed is to be reduced by flange b^2. This shaft passes through the bearing in the frame and inside the frame has a double disc arrangement "a" keyed on to it as shown at "b^1". This double disc carries the rollers "e". The two rings are shown at "h" and "k": these are made of hardened steel as also are the rollers. The ring "h" is keyed, or pressed, into the frame of the machine. The ring "k" is attached by a flange and is keyed on to the low speed shaft "l" which drives the reduced speed shaft by the flange "m". It will be seen that the rollers have two diameters "e" and "d" and have pivots at "c". It is evident when the high speed shaft is set in motion, there being enough play in the pivot "c", the rollers will all be thrown out against the rings "h" and "k" and roll around on them. This, as before explained, will cause the ring "k" to move round slowly, the speed depending on the difference between the diameter at "e" and "d".

The method of calculating reduction in this machine is exactly the same as for a type of epicyclic gearing with which many readers will be already familiar. In an actual model which was constructed and run with some success, the diameter of the ring "h" was made larger than that of the ring "k" and the rollers made to correspond. In this case the formula for reduction was as follows :—

$$\text{Reduction} \quad \frac{(d^1 \quad d^3)}{(\quad d^3 \quad)} \quad \frac{(d^1 \quad d^2)}{(\quad d^2 \quad)}$$

Where d^1 equals diameter of the larger ring "h", d^2 equals the diameter of the small ring "k", d^3 equals the large diameter of the roller, and d^4 equals the small diameter of the roller.

The first model constructed was to be rated at 1½ h.p., 1,500 to 36 revolutions per minute, and to show what this works out at we give the diameters as follows :

$d^1 = 10.05''$ $d^2 = 9.95$ $d^3 = 2.95''$ $d^4 = 2.85''$

In runing the model it became evident that the machine would take a greater power than this, the co-efficient of rolling friction between the rollers and the rings proving much higher than had been calculated.

The writer would be pleased to hear the comments of practical men and designers on this gear.

A rough model has been constructed, as has been mentioned, and it proved that the gear had ample power. There were some errors in the design, however, which made the pivot bearings give trouble, but it would seem evident that this can be easily overcome.

COAL COMBUSTION.

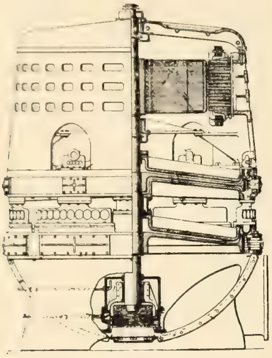
Mr. M. C. Huyeth, of the Murphy Automatic Furnace Company, delivered an address on November 15th before the Toronto branch of the Canadian Association of Stationary Engineers on the subject of "Coal Combustion, Cost of Power". The problem for preventing the escape of smoke, he said, could be solved by a proper system of feeding the boilers, and this would naturally result in a saving of fuel. The lecture was illustrated by lime-light views.

The B. C. Copper Company's mines and smelter at Greenwood are being enlarged and new electrical equipment put in. The Canadian Westinghouse Company are supplying same, which includes five locomotives beside a number of induction motors.

Mr. J. R. Reid, of the Vancouver branch of the Canadian Westinghouse Company, will go to Pittsburg for his Christmas vacation and attend the salemen's meeting of that company. Mr. Seth B. Smith, of the Vancouver office, will also be in attendance.

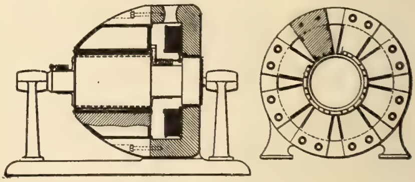
INVENTION and DEVELOPMENT
IN THE ELECTRICAL FIELD

Improved Steam Turbine.—An improved turbine has been patented by William L. R. Emmet, of Schenectady, N. Y., and the patent obtained thereon has been assigned to the General Electric Company, Schenectady. The object of the invention is to improve and simplify the construction of elastic-fluid turbines and also to make them more efficient. In carrying out the invention, the shaft is mounted in a vertical position and rigidly attached thereto are the bucket-wheels and also the revolving member of a dynamo-electric machine. The vertical arrangement is highly advantageous in that the tendency of the shaft to spring and cause the wheel-buckets to rub on the stationary parts is overcome. It also overcomes a difficulty in loading the several bearings evenly. The shaft and bearings can also be made shorter for a given size machine, because the weight is supported by a step or thrust bearing, the other bearing or bearings merely acting as guides, which do not carry weight. In other words, the pressure is removed from all of the bearings except the step or thrust bearing.


Improved Steam Turbine.

Tests of Osmium Lamps.—Experiments were recently carried out at the Technological Institute of Vienna to determine the average life and power consumption of osmium lamps. Six lamps of 35 volts and 16 candlepower and six lamps of 35 volts and 25 candlepower were employed for testing purposes. The lamps were connected three and three in series, and the groups thus formed were placed on an alternating-current circuit at 105 volts. The horizontal luminous intensity and the consumption were measured every 100 hours, until the lamps were destroyed. The results obtained were as follows: A lamp of 16 candlepower gave at first 15.1 candlepower, with a consumption of 1.68 watts per candlepower. After 400 hours, the luminous intensity increased to 17.3 candlepower, and at the end of 2,100 hours fell again to 15.6 candlepower. The consumption went down to 1.46 watts per candlepower, and then went up to 1.58 watts. Another lamp of 16 candlepower gave at first 15.2 candlepower, then 17.5 after 400 hours, and 16 at the end of 2,200 hours. The corresponding power consumption were 1.62, 1.43 and 1.535 watts, respectively. A lamp of 24 candlepower gave at first 22.35 candlepower, then 24.6 after 600 hours, and 23.7 after 1,700 hours. The power consumptions were, respectively, 1.65, 1.51 and 1.56 watts. Finally, a lamp of 23 candlepower gave 22.25 candlepower at first, 24.1 candlepower at the end of 300 hours and 22.6 candlepower after 2,100 hours, the corresponding power consumptions being 1.65, 1.53 and 1.61 watts. It will be seen by the tests that the average life of the lamps was 2,200 hours, the limiting values being 1,793 and 3,036 hours. Among the lamps tested, three alone presented a diminution in light of 10 per cent., one after 1,750 hours, the other after 940 hours, and the third after 820 hours. In taking as a basis the lamp which diminishes 10 per cent. in lumbinous intensity, the average life is found to be 1,985 hours, and the average power consumption 1.60 watts per candlepower for a lamp of 16 candlepower and 1.80 watts for a lamp of 25 candlepower. The candlepower in the results is given in terms of the Hefner candle.

Dynamoelectric Machine.—Charles P. Steinmetz, Schenectady, N. Y., has assigned to the General Electric Company a patent recently granted to him on a dynamoelectric machine. The invention relates to dynamoelectric machines of the type known as "homopolar." The use of steam turbines as prime movers is rapidly removing the objection to the use of homopolar machines based on their low voltage, since with sufficiently high speed such machines may be designed for commercial purposes without an undue number of collector-rings, while the absence of a commutator makes them particularly suitable for high speeds. One object of the invention is to provide a novel form of homopolar machine in which the second objection shall be met by the elimination of the armature reaction, which has hitherto rendered the regulation of such machines too poor for service where constant potential is required. In the embodiment of the invention a drum-armature is provided, carrying at or near its periphery a plurality of conductors. A field structure has a plurality of like poles extending radially inward and surrounding the armature, the poles extending into close proximity to each other adjacent to the armature so as to form a "homopolar" field and


Dynamoelectric Machine.

diverging from each other as they recede from the armature.

A Variable-Speed Steam Turbine.—A variable-speed steam turbine has been patented in England by Mr. W. J. A. London, and is described briefly in the *Mechanical Engineer.* The principle of operation consists in providing two sets of steam admission ports, into either of which steam may be directed at will. From one side of these ports the steam is conducted through expanding nozzles to the rotor, where it encounters two sets of movable blades and one set of fixed blades. It then passes to the exhaust port. This arrangement gives the higher speed. When steam is admitted through the other set of ports, it passes first through nozzles and then through the group of blades just mentioned, but in issuing from these is led through a channel to a second group of blades consisting of two fixed and two movable sets. This arrangement gives a speed about one-half that of the other. It is claimed that in this way two or more speeds may be be obtained, all at approximately the same efficiency.

Electric Motor for Railway Work. — A French engineer, Mr. A. Collet, has developed an electric system for constructing and maintaining railroads which is thought to embody a considerable advance over the hand labor which has been standard throughout the world. M. Collet's system consists of a small portable generating plant and a number of portable motors driving the tools. The generating plant is composed of a twenty-five horse power steam engine driving a generator. This is mounted on wheels, so that it can be drawn along the track to the point at which the work is to be conducted and then lifted conveniently to one side. The tools used in connection with this are a drilling machine for drilling holes in the ties for the wood screws which are to-day used in France for fastening down the rails; a second machine for driving the screws home; and two other machines which are employed for tamping the ballast about the ties. These tools are mounted on light trucks, and can be lifted easily out of the way to allow a train to pass. They draw their supply from a trolley wire stretched to one side of the track. It is said that the system works much more rapidly than a gang of laborers. Four men can set 200 screws in ten minutes —about one-seventh of the time required to do the work by hand. A tie can be tamped in one minute, four men being required at the tools and two to supply the ballast.

Heusler's Magnetic Alloys.—B. V. Hill has made some further discoveries in connection with the magnetic alloys of non-megnetic metals discovered by Heusler. He finds that they show an irreversibility with regard to high temperatures, just as the nickel steels show an irreverisibility with regard to low temperatures. He worked with an alloy containing 60 per cent. copper, 25 per cent. manganese, and 15 per cent. aluminum, and another alloy containing more aluminum. The latter showed an induction $B = 5,750$ c.g.s. in a field $H = 87$ c.g.s., with a comparatively large hysteresis. It was then subjected to repeated heating and cooling. Starting with a magnetic intensity of 311 units, the curve fell till it reached the axis at 320 deg. On cooling, the magnetization was found to be only 267] units. On heating again, the magnetization did not disappear completely, but remained as high as 7 up to 500 deg. On cooling, it appeared much diminished, being only 27 deg. at ordinary temperatures and 36 deg. at the temperature of liquid air. The author attempted to restore the magnetization by heating to dull redness, but only attained an intensity of magnetization of 90 units. Heating to a bright red made this 155 units, and subsequent exposure to liquid air 165 units. The other alloy, heated to 950 deg., lost its magnetism permanently and became 14 per cent. lighter. The nickel steels are heavier in the non-magnetic state.

A Direct-Current Turbo-Generator.—A description of a turbo-generator exhibited at the Liege Universal Exposition is described briefly by M. G. Reyval in *L'Eclairage Electrique* (Paris). This unit is of the vertical type, the turbine being placed below, with the generator above. The lower section, which first receives the steam, is of the action type, and has four wheels, steam impinging upon the outer periphery, rebounding, and being carried by a series of channels to the four wheels in succession. From here it passes through the reaction wheel, which consists of five rows of blades, dovetailed into the outer rim of a nickle-steel spider. The steam passage through these buckets increases in area, allowing the steam to expand on its way through. The weight of the shaft is borne by a step-bearing, lubricated by oil under pressure, the pressure being supplied by the exhaust steam, so that the quantity of oil passing through the bearing varies with the load. Oil, after passing through the bearing, is received back into a resevoir, where it is cooled by water pipes. The turbine is governed by controlling the quantity of steam admitted through the inlet nozzles. This particular unit was rated at 300 horsepower, and revolved at 3,000 turns per minute. The performance was said to be a consumption of 6.3 kilogrammes of steam per horse-power-hour, with a superheat of 300 degrees, at a steam pressure of 175 pounds.

Storage Battery Charging Receptacle.—The Westinghouse Electric & Manufacturing Company have recently placed on the market a storage battery charging receptacle having many advantageous features, among the more important being a swivel attachment which conforms the receptacle to standard steam railway practice, and allows the car or vehicle to start and pull out the cables without danger of breaking them, or the contacts. The apparatus is adapted to both railway and automobile service, and has been adopted by the Pennsylvania Railroad for charging the batteries on their cars.

Sympathetic Lady—"Very sad that your husband should have lost his leg! How did it happen?" Mrs. Muggles—"Why, he got run over by one o' these 'ere substraction engines, miss!"—Punch.

The City of Vernon, B.C., is embarking on a municipal electric lighting venture. Steam power will be used for driving the generator. The steam plant will consist of a 250 h.p. 14 and 26 × 36 Jenckes-Corliss steam engine, horizontal return tubular boilers, 9 × 14 × 16 independent jet condenser, boiler feed pump and feed water heater, all complete, and recently shipped by the Jenckes Machine Company, Limited, Sherbrooke, Que.

GENERAL NOTES.

Cooling water for petrol motors is frequently prevented from freezing by adding 20 to 25 per cent. of glycerine.

Transmission line conditions are considered to be very good if, for continuous use, 1 per cent. of the insulators does not have to be replaced each year. Taking a circuit having 12,000 insulators installed, there would be at least 120 renewals each year.

Power gas is best made from small anthracite pea or gas coke, according to E. A. Dowson, an English gas power expert. He claims the use of bituminous coal is successful only in the Mond process and then only in large installations, owing to difficulties in cleaning.

Patentable ideas were developed to the number of 1,412 at the works of the General Electric Company last year by the various departments engaged in experimental work. Of these 615 were carried to such a stage of development that applications were made for patents covering them.

The power consumption of electric lamps was summarized as follows by Prof. H. T. Davidge in a recent paper before the Junior Institution of Engineers: Incandescent lamps, 2¼ to 4½ watts per candle-power; enclosed arc lamps, 2½ to 4 watts; Nernst lamps, 1½ to 2½ watts; open-arc lamps, 0.8 to 1½ watts.

The limiting speed of gear wheels, figured for the pitch circle, in feet per minute, is placed by Mr. W. H. Thornbery in a paper read before a recent meeting of the Birmingham Association of Mechanical Engineers as follows: Ordinary cast-iron wheels, 1,800; helical wheels, 2,400; mortise wheels, 2,400; machine-moulded cast-iron wheels, 2,000; machine-moulded steel wheels, 2,500; machine-cut wheels, 3,000.

Tests of cylinder oils made by exposing them for four hours in thin films to the action of steady currents of air at 212° and 400 Fahr. are reported by Messrs. F. W. Richardson and H. N. Hanson, in the "Journal" of the Society of Chemical Industry, to be more reliable than mechanical tests. The action of superheated steam on a drying oil is similar to that of hot air, it is stated, although less rapid, so that the oxidizing of an oil in a current of hot air tests its gumming properties.

A manufacturer of rubber gloves states that, although testing with water is an excellent way of finding imperfectly made joints, it is useless for detecting grit or air bubbles below the surface. He suggests that these defects in the materail be tested for by applying a high-voltage alternating current in water, the potential to be from 5,000 to 10,000 volts according to requirements. Each pair should be tested separately and guaranteed, as it is useless to test a sample pair and rate others on the result thus obtained.

A chimney gas temperature averaging 300° C., or 320° at the base of the stack, is as high as it is useful to have, according to a paper by Mr. John W. Cobb in the "Journal" of the Society of Chemcial Industry. The velocity of the gases in the chimney will be increased by a higher temperature, but their destiny will be so diminished that the weight of gases moved will be lower than at the temperature mentioned. Mr. Cobb also points out that a very low temperature at the foot of a stack is not necessarily a sign of economical working, as sometimes asserted, but may be due to a leakage of air between the furnace and chimney. Consequently it is necessary to determine the composition as well as temperature of the flue gases in case thorough investigations are being made.

Centrifugal pump tests are being made on a large scale under the direction of Prof. D. W. Mead in the new hydraulic laboratory of the University of Wisconsin. A specially-designed 1,000,000 gal. centrifugal pump, which is fitted so a wide range of types of impellers may be used in it, has been built for this work, and will be run at various rates of speed up to 3,000 r.p.m., or possibly higher. Extensive experiments will also be made on full-sized apparatus to determine the effect of gates, submerged orifices and screen racks on the flow through intakes and similar waterways. Patented apparatus that is offered will also be tested. Bulletins giving the result of these tests and experiments will be published by the University. The new laboratory, 48x96 ft. in plan, has two stories and a basement and is very favorably located for carrying on large scale experiments. *Engineering Record.*

At Montgomery, Alta., four direct current, 500-volt generators are operated by synchronous motors, which are driven by the current from a water-power plant 30 miles away. The motors and direct current generators are so arranged that they can be operated by steam engines in case of any trouble or any shutdown at the hydraulic station. The synchronous motors are then driven by the engines, and become alternating current generators, furnishing the alternating current.

A new method of utilizing the ends of burned-out arc carbons has been brought out by an Austrian engineer, Louis Bernard, who is at the head of the Brixen electric plant in the Tyrol. He finds that the pieces of carbon can be joined together by a cement made of water-glass so that they will form a single stick, and this can be used in the lamp and will burn as well as a new carbon. To join the pieces together it is only necessary to square off the ends so that they will make a good fit. The ends are coated with a cement which is made of a mixture of water-glass and finely powdered carbon. The pieces are pressed together lightly, and when the cement dries a very solid joint is formed. It appears that the electric resistance of the joint is not appreciable, and there is no difference in the working of the lamp. At the same time the prepared carbon is about as solid as a new one.

In a recent issue of Comptes Rendus, E. Rogouski reports the results of tests which showed that when thin bare silver wires are immersed in flowing water kept at a uniform temperature, and the current through them is gradually increased, the resistance decreases at first and then increases again. He gives a satisfactory explanation, based upon the presence of a molecular layer of water adhering to the wire. This layer prevents the temperature of the wire from becoming that of the surrounding water. It allows it to rise above it, and the resistance measured is not that of the wire at the temperature of the flowing water, but the resistance at a temperature a few degrees higher than that, and therefore greater than the value sought. When the current becomes stronger, the difference of temperature on both sides of the molecular layer increases, and when it becomes about 4° the layer breaks up and allows the water to flow in immediate contact with the wire. The resistance of the wire is then the true resistance at the temperature of the water.

The time usage of electric lights and motors has recently been investigated by Mr. Arthur Williams, of the New York Edison Company, and communicated to a recent convention at New Castle, N. H. In twelve large buildings in New York city, the average daily use of each installed lamp in a recent year was 3.22 hr., ranging from 14 per cent. below the average to 58.7 per cent. above. Of five large New York clubs the annual use averaged 4.75 hr., the range being 22 per cent. below to 16 per cent. above the average. For motors in smelting works the average use was 0.48 hr. for each horse power of the rated capacity; instrument makers, 3 hr.; machine shops, 2.1 hr.; general machinery, 4.56 hr. The average of fifty motors was 2.26 hr. per day for each rated horse power. Tests showed that the cost of operating ceiling fans on the basis of 10 cents per kilowatt-hour is 1.58 cents. For driving sewing machines the cost is 0.35 cent for belt-driven machines, and 0.2 cent for direct connected machines.—*Engineering Record.*

The twenty-seventh regular monthly meeting of the Toronto branch of the American Institute of Electrical Engineers will be held at the School of Practical Science (old building) on December 22nd, when a paper on "The Booster Control of Storage Batteries" will be presented by Mr. E. B. Walker.

Electrical Machinery

Having in contemplation certain improvements during the summer of 1906, to increase the capacity of our plant, the following Generators may be available for sale, provided suitable offers can be obtained.

One 60 K. W. Stanley 2 Phase Inductor. 133 Cycle
One 360 K. W. Stanley 2 Phase Inductor, 133 Cycle.

Condition, practically as new.
Correspondence is invited.
Address

. . **The** . .
Sherbrooke Power, Light & Heat Co.
Sherbrooke, Que.

TELEGRAPH and TELEPHONE

TELEPHONE COMPANIES IN QUEBEC.

There are located in the Province of Quebec a larger number of telephone companies than in any other province of the Dominion. A list recently compiled for the House of Commons Telephone Committee showed that—exclusive of the Bell Telephone Co., which though having its head offices in Montreal, carries on business under its general charter in other parts of Canada—there were 28 separate and distinct telephone companies carrying on business in Quebec. A list of these is appended :—

Jos. Archambault, L'Epiphanie.
Beauce County Telephone Co , St. de Beauce.
Beauce Telephone Co., St. Francois.
Bellechasse Telephone Co., Levis.
Canadian Telephone Co., Sawyerville.
P. Deshaise, Doucet's Landing.
Eastern Townships Telephone Co., Sherbrooke.
Electric Light and Telephone Co., Solomon A. St. Pierre.
Fournier Villemarie, St. Valere de Bulstrode, Drummond, Arthabaska.
F. Gauthier & Co., Drummondville.
Joliette Telephone Co., Jolliette.
Kamarouska Telephone Co., Fraserville.
Laurentides Telephone Co., Laurentides.
H. Lemieux & Sons, Murray Bay.
L'Epiphanie Local Telephone Co., L'Epiphanie.
Megantic Telephone Co., St. Julie de Somerset.
Merchants' Telephone Co., Montreal.
Metis Telephone Co., Little Metis.
People's Telephone Co., Sherbrooke.
T. B. Rider, Fitch Bay.
Roberval Telephone Co., Roberval.
St. Laurent Telephone Co., St. Francis du Lac.
St. Lawrence Telephone Co., St. Francis du Lac.
St. Maurice Telephone Co., Shawenegan.
St. Maurice Telephone Co., Three Rivers.
St. Winceslas Parish Telephone Co., St. Winceslas.
St. Zepherin Telephone Co., St. Zepherin.

THE LATE HON. A. M. McKAY.

The death occurred on November 23rd last, at St. Johns, Newfoundland, of Hon. A. M. McKay, superintendent of the Anglo-American Telegraph Company in the Island. Mr. McKay was born in Pictou, N. S., in 1834. He studied the art of telegraphy and worked in several cities in Canada, where he proved so capable an operator that simultaneously with attaining his majority, he was chosen by the famous Cyrus Field to become the first superintendent of the New York, Newfoundland and London Telegragh Company, subsquently the Anglo, then about to establish its land line across this Island preparatory to the laying of the first Atlantic cable. Mr. McKay accepted the position and from then to the hour of his death was actively and honorably indentified with the progress of terranean and submarine telegraphy in this northern region. His life since then has been an epitome of the development of this marvel of modern science. In recognition of his splendid work the directors of that concern, men famed the world over—Cyrus Field, Peter Cooper, Moses Laylor, Marshall Roberts, Chandler White and Frederic Gisborne—presented him some years later with a handsome cabinet of silver, and he was subsubsequently the recipient of many other costly testimonials.

For over a generation in commercial life, and in his business relations, Mr. McKay was universally respected, and chosen as an arbitator by the Supreme Court and private litigants in nearly every case of the first magnitude decided at St. Johns by this process the past thirty years. Twenty years ago he was stricken with a serious illness and his recovery was almost miraculous. Until last winter he continued vigorous and active, but since then had been declining till the end came. He was married in 1860 to Miss Elizabeth O'Neil Orp, of Pictou, who survives him, as do seven of his children.

SHORT CIRCUITS.

The Bell Telephone Company have completed a long distance line from Sault Ste. Marie to Blind River, Ont.

Two additional metallic circuits between Toronto and Hamilton have just been completed by the Bell Telephone Company.

Mr. W. J. Duckworth, inspector G.N.W. Telegraph Company, has been appointed superintendent of maintenance and construction, succeeding Mr. A. B. Smith.

The Canadian Telephone Machine Company and the Ontario Telephone Company have made applications for a franchise at Brantford, Ont., while the Bell Telephone Company are endeavoring to secure a renewal of their present franchise.

Messrs. W. J. Moffat, J. A. Tremblay and others are forming a telephone company under the name of the Ontario Farmers' Telephone Company, Limited, and have been granted a sole franchise within the Township of Tilbury North for 21 years.

Members of the construction staff of the Bell Telephone Company are installing a new switchboard in the Winnipeg Exchange. The list of subscribers in Winnipeg is steadily growing and the new board is designed to meet the future needs for some years to come.

Premier Roblin, in addressing a convention at Winnipeg recently, declared himself in favor of a Government system of telephones in Manitoba. The scheme outlined embraced a trunk line for all the municipalities, to be constructed by the Government, the municipalities to build all branches desired.

The British Columbia Telephone Company announce that $250,000 will be expended next year on the system in Vancouver. A complete underground system on all business streets, a three-storey fireproof building and the installation of a central energy switchboard, are among the proposed improvements.

The Home Telephone Company, which has systems in about 25 different cities of the United States, has made application for a franchise from the City Council of Vancouver, B.C. Mr. W. J. Arment, of Portland, Oregon, states that the company are ready to spend a million dollars in Vancouver in the installation of an automatic telephone system.

Owing to the increasing difficulty of securing a supply of poles, the cost of building telegraph and telephone lines has increased somewhat during the past few years. Suitable poles which could formerly be bought at a 90 cent rate are now quoted at $1.45. Thirty-five poles are needed per mile, making the cost for the poles alone about $50 per mile.

The property and plant of the Cumberland Telephone Company, Limited, Amherst, N.S., was sold last month by the liquidator to Dr. A. W. Hudson for $14,000. The company was organized three years ago, with a capital of $50,000. Over seventy miles of line were in operation, carrying 350 instruments. It is understood that a strong company will be formed to continue the operation of the system.

The Locke Insulator Manufacturing Company, Victor, N. Y., have designed a transposition insulator for the support of telephone wires on the same poles which carry the high voltage wires. A prominent feature of the insulator is the great arcing distance between the telephone wires and the support. There has been provided between the two telephone wires a small petticoat which affords ample insulation between them. This insulator is made in one piece, and is characterized by great mechanical and electrical strength

ONTARIO'S WATER POWERS.

Mr. Cecil B. Smith, writing on the above subject in Queen's Quarterly, says :

"Roughly speaking, the capital investment for well built plants varies from $50 to $100 per horse power of electrical energy ready to transmit to a distance.

"The plants at Niagara Falls, Ont., and vicinity, all come well below $100 per h.p., and as the cost of maintaining and operating them, as well as providing a sinking fund and paying interest on investment, are fairly well known, it is evident that in that district power should be bought for a very reasonable figure. As a matter of fact at present sales of large blocks of power are yet infrequent, but a recent sale at $12.50 per 24 hours horse power per year on the bus-bars, or receivers of the step-up transformer station, will give a close indication of values.

"The urban population of western Ontario within economical reach of Niagara is about 550,000, and as electrical energy and coal should be both higher one will about offset the other. We may conclude, therefore, that 50,000 to 60,000 h.p. is all that will be transmitted westward from the Fallls and vicinity for some years to come unless the steam railways break away and adopt electric traction on their trunk lines, in which case the consumption would at once be doubled or trebled.

"Now, the present condition of Niagara power may be summed up thus. The Hamilton Company, near St. Catharines, have a 16,000 h.p. capacity for twenty-four hours now developed, and propose to increase their machinery equipment to meet demands until 40,000 h.p. for ten hours will be on sale. The Canadian Niagara Power Company, allied to the Niagara Falls Power Company of the United States side of the river, have built a 100,000 h.p. plant, have 30,000 h.p. of this on sale, and 20,000 additional ready to install—50,000 in all, of which 40,000 will be available for sale. The Electrical Development Company are building a 105,000 h.p. plant, and at present contemplate the installation of 40,000 h.p. of machinery, of which 30,000 h.p. will be ready to transmit in about fifteen months to Toronto and vicinity. The Ontario Power Company have 60,000 h.p. development nearly complete, 30,000 h.p. of machinery being now under test, and 40,000 h.p. additional soon to be added. But this company have headworks built for 180,000 h.p. and look forward to this as their ultimate output. Besides these there are small developments for street railway and town purposes, and along the old Welland Canal various small industries operate from water power.

"But dealing only with the four large Canadian companies, we see that 400,000 h.p. of 24 hour electrical energy is at present in course of development, and of this 146,000 h.p. of 24 hour service will soon be in the market, or even a load peak of 170,000 to 180,000 h.p. during busy hours.

"Of this power 30,000 h.p. is already sold for distribution in the United States, and two of the companies have charter rights to sell one-half of their output in that country. But it is evident that there will be plenty for all in a year or two, when these various companies get into good running order. Meantime an important and indeed the vital problem before the public is how to obtain effectively and on reasonable terms the great advantages of Niagara power throughout its sphere of influence."

CANADA'S MOTIVE POWER.

Mr. W. N. Deitrich, chief electrical engineer of the C.P.R., read a paper last month before the Young Men's Association of the Maisonneuve Presbyterian church, Montreal, on the subject of "Canada's Motive Power".

The paper was a comprehensive one, dealing with the growth of the Dominion, the increase of motive power which will be required consequently, and the sources of supply of this power. The vast coal deposits in various parts of the world were now tapped to furnish fuel to produce power. These deposits would become exhausted in three hundred years at the present rate of consumption, he estimated, and as they diminish in quantity the cost of coal would increase until it would not be available for power purposes. Hence other power must gradually take the place of coal, and so far as Canada was concerned, the development of water resources was advisable.

Speaking of electricity, Mr. Dietrich said: "The total motive power in use in the world to-day is 600 per cent. more than what it was thirty years ago, and there is no doubt but that this tremendous increase is due in large measure to the invention and introduction of the many and various electrical devices in use at the present time. Transportation on sea and land which is so essential to industrial enterprise could not be conducted on anything like present proportions without the aid of the submarine cable, the telegraph and the telephone. In twenty years the incandescent and the arc lamps have brought about a complete revolution in systems of lighting. Ten years ago the operation of machine tools by electric motors was in the experimental stage. At the present time over half a million horse power of electric motors are performing satisfactorily the work for which they are designed. Seventeen years ago less than 100 miles of electric railway were in operation on this continent. Now there are about 35,000 miles with about 75,000 cars, which use continuously about a million and a half horse power of electrical energy, and earn annually a quarter of a billion dollars. The most important problems before the engineering world to-day are those in connection with the electrification of the present steam railroads. When this comes about our Canadian roads can avail themselves of the many water powers distributed throughout their lengths, and banish the fuel problem in connection with the question of motive power."

PRINTING PRESS INDUSTRY.

Because of the fact that the Westinghouse Electric & Manufacturing Company make the largest units required for the production and transmission of electricity, comparatively few people know that in the same works at East Pittsburg are manufactured also the smallest units to meet the needs of printing establishments and similar lines of industry. It is a matter of considerable gratification to the company to see the favor with which their motors for the printing industry have been received. There have very recently been closed three contracts aggregating in the neighborhood of 400 motors, and the company are in a position to undertake the equipment of printing establishments from the smallest to the largest machines required in this industry.

OPERATING COST OF ELECTRIC ELEVATORS.

The following data upon the cost of operating electric elevators appears in a recent publication of the Cincinnati Gas and Electric Company. While the cost varies greatly with the type, and the extent to which the elevator is used, the following figures, we think, give a fair average for the guidance of prospective users of electric elevators:

SIX MONTHS' AVERAGE.

No.	H. P.	Freight Elevators. Average Monthly Cost.	No.	H. P.	Passenger Elevators. Average Monthly Cost.
1	10	$11.92	1	15	$39.54
1	10	10.00	2	20½	19.05
5	20	33.01	1	18	65.83
1	5	5.00	2	17½	17.30
1	5	4.00	2	22½	23.57
1	5	5.00	1	15	14.22
1	5	4.00	5	73	59.40
1	5	7.37	2	32	38.16
1	5	4.00	3	38½	34.55
1	5	11.86	2	10½	19.80
1	10	9.50	1	8	9.73
1	10	9.50	1	8	14.87
1	8½	9.49	1	11	18.42
2	25	23.75	1	15	9.15
1	5	3.50	1	15	22.01
1	10	9.50	1	15	4.75
1	5	4.75	2	16½	17.62
1	10	11.30	1	12½	14.66
1	8	7.60	2	12½	12.33
1	20	28.06	2	11	17.74
1	7½	7.12	3	41	37.95
1	5	4.75	1	10	23.49
1	5	4.60	1	16	18.24
1	5	5.25	1	10	19.05
1	7½	7.12	1	10	19.50
			1	13	13.30
30	221½	$241.95	1	10	18.98
			1	26	35.31
			45	523	$658.58

Average cost per elevator per month, $8.

Average cost per month per horse-power, $1.09.

Average cost per elevator per month, $14.64.

Average cost per month per horse-power, $1.26.

The average monthly cost for a freight elevator is $8.00 and for passenger elevators $14.64. It will be evident that these figures cannot be duplicated in a steam or hydraulic equipment.

WETASKIWIN ELECTRIC LIGHT PLANT.

A very complete little municipal electric lighting plant is that of Wetaskiwin, a progressive and growing town on the Calgary and Edmonton branch of the C.P.R. The plant, which was installed in January, 1905, consists of an Allis-Chalmers-Bullock 75 k.w., 2,300 primary and 112 secondary, 2-phase, a.c. generator; a Robb-Armstrong tandem compound engine of 120 h.p. and two Mumford boilers of 70 h.p. each. A Hopp heater for heating the feed water is in connection with the boilers.

The machinery is housed in a building 43 × 73 feet, the dynamo room being 33 × 41 feet and the boiler room 38 × 41 feet. The brick smoke stack runs up to a height of 76 feet. The street lighting is done by sixteen series arc lamps of the Adams-Bagnall type. Besides this about 1,500 lights of 16 c.p. each are supplied, thus taxing the plant to its full capacity.

A number of applications for the supply of power have already been received and it is not unlikely that by another year the officials in charge may increase the plant sufficient to meet this demand. Mr. G. R. Taylor is the chief electrician in charge, with Mr. W. H. Brodie as assistant.

ECONOMY IN STEAM POWER.

At the last monthly meeting of the Canadian Railway Club, Professor R. J. Durley, of McGill University, read a paper on "Economy in Steam Power Plants".

"Although there is a great future before the gas engine as a source of power," said Professor Durley, "the time has not quite arrived when it can be looked on as a commercial competitor with the steam engine or turbine under any but exceptional circumstances. At the present time a producer gas plant for anthracite coal, with gas engines and generators, will cost in Canada about 20 per cent. more than a steam plant to take the same peak load. The cost for fuel at high load factors is considerably less for the gas plant, but this saving is much smaller at low load factors, on account of the higher fixed charges."

Dealing with engine room costs, Professor Durley stated that engineers on this side of the Atlantic had been somewhat slow to realize the very excellent results which had been and were being obtained in Europe from the use of superheated steam. The installation of superheaters was, however, coming more and more into favor in Canada.

The speaker closed his paper with a reference to the cost of labor in the engine room, which depended, he said, not only on the type of motive power adopted, but also very largely on the arrangement of the machinery in the engine room, and especially on the amount and complexity of the auxiliary machinery installed.

GAS POWER PLANT IN CEMENT WORKS.

The Iola Portland Cement Company, of Iola, Kansas, has recently placed an order with the Westinghouse Machine Company, of East Pittsburg, Pa., for three 500 h.p. horizontal double acting gas engines and one 125 h.p. vertical single acting gas engine to increase the capacity of their already large gas power plant. The three horizontal gas engines now on order will be the first of this type to be installed in the power house, the remainder being of the vertical type. After the installation of the engines now on order, the power equipment will comprise 15 engines of the Westinghouse vertical single acting type and three of the horizontal double acting type, aggregating about 4,500 h. p. The company operate their plant upon Kansas natural gas fuel and is one of the largest users of gas power in the cement manufacturing field. The engines are used to operate various classes of machinery, such as rock crushers, rotary kilns, line shafting and generators for supplying power and light throughout the works. The machinery is in general arranged in groups upon sections of counter shafting driven by a single engine either direct connected or rope driven.

In point of size this installation has few precedents and its successful operation under such severe conditions demonstrates the many advantages of gas power in industrial establishments of all kinds.

TECHNICAL EDUCATION.

The Educational Committee of the Young Men's Christian Association, Montreal, is doing good work in providing technical education for young men of Montreal. The Electrical Course is conducted by Mr. Matthew A. Sammett, engineer in charge of the Testing Department of the Montreal Light, Heat & Power Company. Students of the two classes—elementary and advanced—are given a thorough course, the work of the advanced class including theory of direct and alternating current machinery, and testing of same. Both classes are well patronized and to a great extent supply the need of technical education.

Mr. Willis Chipman, C. E., of Toronto, will report to the Council of Saskatoon, N.W.T., as to the cost of electric light, sewerage and waterworks systems.

THE NIAGARA TOWER DAM.

Toronto, November 24th, 1905.

Editor Canadian Electrical News:

Dear Sir,—You kindly gave me space in your October issue for a letter of protest against the general design of the tumbling tower dam at Niagara. Since then the tower has been thrown to its place in the stream, and opinions vary as to the degree of success attained. The daily press say the 'Uneven bed of the river caused great blocks of concrete to lie in *rather* fantastic shape. The section next the top struck a boulder and broke in two. It is *pretty* nearly where it is wanted, but only part is submerged, and can be regarded as only partially successful".

Chairman Sells is reported to have said: "We have 10 inches more water, but would like to have had 20 inches or even 12 inches."

Now, I stated that the dam would be only partially successful and that "If it is to conform to the river bed it will necessarily have to be largest where the river is deepest, and if this is not done then the crest will be above water at one point and below it at some other point. Any additional material to correct this would not be chained to the original mass."

I pointed out that it was not positive engineering, and to one of the City reporters, I gave it as my opinion as being a case of throwing dice, or I may say tossing pennies, "Tails you win, heads I lose," and the results bear me out in this view of the matter. The latest report is that a second tower will be thrown, and if that is not sufficient, then a third one will be thrown on top of the other two.

Such engineering is certainly gambling on a chance, and cannot be regarded as an addition to the meritorious achievements in Canada, or as a proper example to laud before the Canadian people, the Canadian engineering profession, or Canadian students in engineering; and strive as the authors of this design may do, to raise the water in the intake to the desired level, they are still unable to tell what degree of permanency this structure will have, and how it will withstand the rush of ice flows in the Spring.

As a matter of fact, there are other ways of doing this work that would be permanent beyond peradventure of a doubt, and that would enable the depth of water to be raised to any desired half-inch in the intake well, and it is surely only right to be honest about the matter and laud a proper scheme and condemn one of another sort.

Yours truly,

Jno. S. Fielding, C. E.

EXCELSIOR BABBITT METAL.

Mr. J. R. Stratton, of Moncton, N. B., has invented a new babbitt metal called the "Excelsior," which is being placed on the market by the Excelsior Car Bush and Babbitt Company, of Moncton. The babbitt is a new composition in anti-friction metals. We understand that it is not a lead and antimony babbitt like those in common use, but contains only a very small proportion of those metals. It is about 25 per cent. lighter in weight, and it is claimed that its melting point is more than twice as high, and although it is harder, does not cut or wear the journal, while its durability is said to be from three to four times that of the babbitts in ordinary use and its anti-friction qualities are nearly perfect.

The Company advise us that the metal has been in use under test conditions in the hardest places that could be found for about two years and has given complete satisfaction and received the approval of the Shives Lumber Company and William Richards Company, Campbellton, N.B., Dominion Iron & Steel Company, Sydney, N. S., Record Foundry & Machine Company, Moncton, N. B., and other large concerns. Having demonstrated the merits and usefulness of the metal by extended test, the Company are now arranging to place it on the market, being satisfied that they have an article that will effect a large saving to users of anti-friction metals and command a ready and extended sale. The babbitt can be used in ordinary shells, but they consider that their shell filled with their babbitt will make a complete bearing more useful and economical than solid brass or any other kind of bearing. The manager of the company is Mr. R. A. Borden.

The Westinghouse Machine Company, East Pittsburg, Pa., have issued a very complete catalogue referring to the Westinghouse standard steam engine.

PUBLICATIONS.

Printed literature has been received from John Forman, 708-710 Craig street, Montreal, referring to the American transformer for thawing pipes, Empire miniature lamps, the Kinsman desk lamp and other specialities for which he is the Canadian agent.

A new switch catalogue has recently been published by the Hill Electric Switch Company, Montreal, in which are shown their style "A" and types "B" and "D" quick break switch blades, reinforced switch blades, "Beaver" baby knife switches, etc.

One of the most unique devices which has yet reached us is a wiring computer bearing the compliments of the Simplex Electrical Company, manufacturers of rubber insulated wires and cables, etc., state street Boston, Mass. Full instructions for use of the computer are given and on the back are valuable wire tables.

The Electric Appliance Company, 134-140 West Jackson Boulevard, Chicago, have issued the fourth edition of their Perpetual Price Book, which is designed to furnish the buyer with the means of keeping posted at all times on changing prices. The book is complete in detail and should be found very useful.

"Elementary Electrical Calculations" is the title of a book suitable for the use of first and second year students of electrical engineering which has recently been published by Messrs. Longmans, Green & Company, 38 Paternoster Row, London, Eng. The authors are Messrs. W. H. N. James, A.I.E.E., and and D. L. Sands, and the selling price is 3s. 6d. net.

Whittaker & Company, Paternoster Square, London E. C., England, have issued the second edition of "The Alternating Current Circuit and Motor," by W. Perren Maycock, M.I.E.E. The book is designed to convey some idea of the phenomena of the ordinary or single-phase alternating circuit to the minds of those new to the subject. The second edition has been revised and enlarged and contains a section of single-phase and polyphase motors. The retail price is 4s. 6d. net.

The "Central Station List and Buyer's Manual," published by the McGraw Publishing Company, New York, is doubtless found very useful to manufacturers of electrical apparatus and others doing business with the electric lighting companies. It is issued semi-annually and contains a complete list of the electric lighting central stations in the United States, Canada, Newfoundland and Mexico; also a directory of manufacturers, dealers, engineers and contractors. The description price is $4 per year.

NEW ROUTE TO SOUTHERN CALIFORNIA.

The opening to traffic of the San Pedro, Los Angeles and Salt Lake Railroad, known as the Salt Lake Route, between Salt Lake City and Los Angeles, makes available a most desirable short line to Southern California. This will doubtless be of great interest to the ever-increasing number of people who journey each winter to this sunny clime.

In anticipation of a large volume of this class of traffic a handsome equipment of modern vestibuled trains has been placed in service in connection with the Overland Limited train of the Chicago, Union Pacific and North-Western Line, the most luxurious train in the world. This forms a new and interesting route by which first class tourist travel can reach the sunshine and flowers of Southern California, travelling on fast schedules and in luxurious comfort. Rates, folders and full information can be obtained from B. H. Bennett, General Agent, 2 East King St., Toronto, Ont.

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SPARKS.

Holt, Renfrew & Company the celebrated fur concern of Quebec, will light the village of Indian Lorrette. A Crocker turbine developing 300 h.p., and which was built by the Jenckes Machine Company, Limited, of Sherbrooke, Que., will be the prime mover.

The Crocker-Wheeler Company, through their Canadian representatives, The Packard Electric Company, Limited, have recently secured the contract for supplying the generating apparatus for the Town of Westmount, consisting of two 200 k.w. and one 50 k.w. 2300 volt generators.

The town of Napanee Ont., will now be able to install a municipal light and power plant, a motion of Sir Richard Cartwright to quash the by-law authorizing the town to expend $40,000 on a plant having been dismissed by Judge Meredith. Sir Richard Cartwright is president of the Napanee Light & Power Company.

TRADE NOTES.

The Town Council of Beeton, Ont., have decided to install a storage battery for supplying light after 12 p.m.

Mr. Geo. C. Rough, manager Sales Department of The Packard Electric Company, St. Catharines, Ont., reports that the demand for Type "G" meters has been such during the past year that it has taxed the capacity of the factory to the utmost. Arrangements are being made to increase the facilities in anticipation of a still greater demand for these well known meters during the coming year.

The Westinghouse Electric and Manuacturing Company have perfected a new line of three-phase core type transformers for 6 cycle circuits. One of these transformers may be used where three-phase transformation is to be made, instead of two or three of the single-phase type. They are self-contained units of compact construction, and are generally easier to install, and reduce the complexity of wiring between the transformer and the apparatus which it is to supply.

Owing to the increase in business and growing importance of Montreal as a center for distribution of their products, the Robb Engineering Company have decided to change their agency at Montreal into a branch office. Mr. Watson Jack has been appointed manager, and Mr. Alister Maclean will continue in the capacity of engineer for the Montreal district. The Robb Engineering Company will have their quarters in the handsome suite of offices occupied by Watson, Jack & Company in the Bell Telephone Building, corner of Notre Dame and St. John Streets.

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SPARKS.

The Canada Woodenware Company have installed an electric light plant in their factory at Hampton, N. B.

Mr. Jacob Morley has named the price at which he is willing to sell his electric light plant at New Hamburg, Ont., to the Corporation, and a by-law will likely be submitted to the electors to provide the money.

The question of a new lighting plant for North Toronto, Ont., has been left for the consideration of the new Council. It is estimated that a plant to provide 3,000 incandescents and 50 arcs would cost about $20,000.

Mr. Roderick J. Parke, E. E., of Toronto, is acting in an advisory capacity for the Town Council of Welland, Ont., which is considering the acquisition of the electric light plant. Some of the Councillors are in favor of discarding the present generating plant and contracting with one of the power companies at Niagara Falls for a supply of power.

Mr. T. G. Nicol has offered to sell his electric light plant at Mahone Bay, N. S., to the corporation for $16,000. The Water Commissioners are prepared to give $12,000 for the plant, and if this price is not accepted, the matter may be submitted to arbitration. This plant will carry about 1,000 16-c.p. lamps, and by raising the dam two feet and installing a larger water wheel, this could be increased to 1,200.

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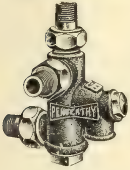

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SPARKS.

Tenders were recently invited for the extension of the electric light system at Newcastle, N. B.

The power plant at Wahnapitae, Ont., is now in operation. It is the intention to supply light and power also to Sudbury, about twelve miles distant.

The City Council of Quebec have withdrawn the advertisement inviting tenders for electric lighting. The present contract expires in 1907, and upon reconsideration it was decided not to receive tenders for a new contract until April next.

The Chatham, Wallaceburg & Lake Erie Electric Railway was formally opened on November 21, the section between Chatham and Wallaceburg having been completed. The road has cost to date about $350,000 and further extensions are contemplated.

The Pre-Payment Electric Meter Company, of Peterborough, Ont., have decided to proceed at once with the manufacture of meters. During the winter their plant will be located in a building on Hunter street formerly occupied by the Colonial Ink Company, but in the spring a new factory will be built.

The renewal of the electric lighting contract at Stratford, Ont., is receiving the attention of the civic authorities. The electric plant and gas works are owned by a private company, and it is understood that the Water Commissioners have been considering the advisability of operating an electric light plant in connection with the waterworks.

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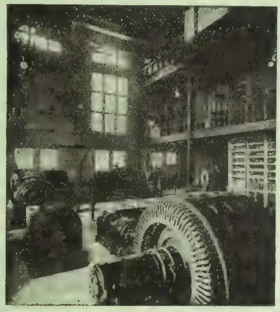

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